

A DRY PORT AS AN EXPANSION OPTION FOR THE CAPE TOWN CONTAINER TERMINAL

By

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Declaration

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Abstract

Currently maritime ports, including the Port of Cape Town, experience congestion, pollution and other logistics-related problems due to increasing levels of container traffic. The presence of these problems has caused port planners, port operators and logistics firms to look for new solutions in this transport sector. The dry port concept, whereby offloaded containers are stored outside the maritime port in a dedicated logistics area, is recognized as a means for solving some of these major problems, thereby promoting economic development and logistics integration as well as reducing the demand on limited capacity (land and access) at the maritime port. Therefore, the core objective of this study is to demonstrate that the implementation of the dry port concept is a feasible alternative for expanding the throughput capacity of the Cape Town Container Terminal.

The Port of Cape Town is strategically one of the best placed ports in South Africa as it is positioned at the South Western extremity of the continent of Africa, thereby linking America and Europe with Asia, the Far East and Australia. Furthermore, the Port of Cape Town also forms a direct link between international trade and about three (3) million consumers in the Western Cape. The recent expansion of the Cape Town Container Terminal was a major investment which included the upgrading of equipment and the expansion of workable surface area, thereby increasing the container terminal yard capacity to 1.4million TEU (TEU = Twenty foot Equivalent Unit) per annum. However, this report showed that the abovementioned increase in volumes as well as the resulting congestion continues to be a challenge at the Port of Cape Town. Firstly, the predicted future container volumes show that the demand in the Port of Cape Town could reach between 1.9 million and 3.2 million TEU per annum by 2039. Secondly, the evaluation of the operational and infrastructural characteristics of the existing Cape Town Container Terminal demonstrated that container terminal yard (CY) area is the capacity limiting characteristic of the terminal and that the operational and infrastructural limits could be reached between 2018 and 2026.

The two main functions of a dry port in the Western Cape transportation network would be international trade processing and congestion relief, which are achieved through the duplication and supplementation of the Cape Town Container Terminal facilities at an inland location. The dry port would allow the Western Cape supply chain to absorb any future container volume demands that exceed the CY capacity of the Port of Cape Town and could potentially attract an

annual throughput of 0.7 million TEU by 2039. Furthermore, the facility could address the problem of congestion in and around the greater Cape Town metropolitan, resulting in an improved transportation network that will have a positive effect on passenger traffic, productivity of trucks, competitiveness of the Port of Cape Town as well as the environmental sustainability of the transportation system. The dry port concept would therefore be appealing to Transnet Port Authority / Transnet Port Terminals, Shippers and Logistics Managers and the Western Cape Regional Community.

The site selection analysis performed in this study evaluated three possible dry port locations, namely: Kraaifontein Area, Ysterplaat Air Force Base and Bellville Precinct. Although the analysis identified that all three of the sites have the potential to be developed into a successful dry port; however, that the Bellville Precinct is the preferred location due to the presence of the Belcon freight rail facility. The success of such a facility will greatly depend on the project's ability to ensure that the resources needed for the initial investment is kept to a minimum, and ultimately the most viable dry port solution in the Western Cape region would be the phased development of Bellville Precinct.

From this it is clear that a dry port could be a feasible alternative for expanding the throughput capacity of the Port of Cape Town, as well as improving the transport infrastructure in the Cape Town area.

Opsomming

Maritieme hawens, insluitende die Kaapstadse hawe, ondervinding tans opeenhoping, besoedeling en ander logistieke probleme as gevolg van toenemende vlakke van die houer verkeer. Die teenwoordigheid van hierdie probleme het veroorsaak dat hawe beplanners, hawe-operateurs en logistiek maatskappye op soek is vir nuwe oplossings in die vervoer sektor. Die droë hawe konsep word erken as 'n middel vir die oplossing van sommige van hierdie probleme, en sodoende ekonomiese ontwikkeling en logistieke integrasie te bevorder, sowel as die verlaging van aanvraag op beperkte kapasiteit (grond en toegang) by die maritieme hawe. Daarom is die kern doel van hierdie studie om aan te toon dat die implementering van die droë hawe konsep 'n haalbare alternatief is vir die uitbreiding van die deurset kapasiteit van die Kaapstadse Houerterminal.

Die Kaapstadse hawe is strategies een van die bes geplaaste hawens in Suid-Afrika, want dit is geleë aan die suid-westerlikste punt van Afrika en verbind Amerika en Europa met Asië, die Verre Ooste en Australië. Verder vorm die Kaapstadse hawe ook 'n direkte skakel tussen die buitelandse markte en die drie (3) miljoen verbruikers in die Wes-Kaap. Die onlangse uitbreiding van die Kaapstadse Houerterminal het die stoorkapasiteit van die terminal aansienlik verbeter an 1.4 miljoen TEU per jaar, deur middel van die opgradering van toerusting en die uitbreiding van werkbare oppervlak. Hierdie verslag bewys egter dat die bogenoemde toename in volumes sowel as die gevolglike opeenhoping steeds teenwoordig is in die Kaapstadse hawe. Eerstens, die voorspelde toekomstige houervolumes toon dat die aanvraag in die Kaapstadse hawe tussen 1.9 miljoen en 3.2 miljoen TEU's per jaar kan bereik teen 2039. Tweedens, die evaluering van die operasionele en infrastrukturele kenmerke van die bestaande Kaapstadse Houerterminal het getoon dat die houer stoorarea die kapasiteit beperkende kenmerk van die terminal is en dat die operasionele en infrastrukturele perke moontlik tussen 2018 en 2026 bereik kan word.

Die twee hoof funksies van 'n droë hawe in die Wes-Kaap vervoer netwerk sal internasionale handel verwerking en opeenhoping verligting wees. Hierdie funksies sal bereik word deur die duplisering en aanvulling van die Kaapstadse Houerterminal fasiliteite by 'n binnelandse perseel. Die droë hawe sal toelaat dat die Wes-Kaap verskaffersiklus enige toekomstige houervolumes, wat meer is as die houer stoorarea kapasiteit van die Kaapstadse hawe, te kan hanteer en kan potensieel 'n jaarlikse deurset van 0.7 miljoen TEU hanteer. Verder kan die

fasiliteit die opeenhoping probleem in en rondom die groter Kaapse metropolitaan aanspreuk en lei tot 'n verbeterde vervoer netwerk wat 'n positiewe uitwerking sal hê op passasier verkeer, die produktiwiteit van vragmotors, mededingendheid van die hawe en ook die omgewings volhoubaarheid van die vervoerstelsel. Die konsep is dus aantreklik wees vir Transnet, verskepers en logistieke bestuurders en die Wes-Kaapse gemeenskap.

Die perseel seleksie analise van hierdie studie het drie moontlike droë hawe persele geëvalueer, naamlik: Kraaifontein Area, Ysterplaat Lugmagbasis en Bellville Gebied. Die ontleding het geïdentifiseer dat al drie die persele die potensiaal het om in 'n suksesvolle droë hawe ontwikkel te word, maar dat die Bellville gebied die beste opsie is te danke aan die teenwoordigheid van die Belcon spoor vrag fasiliteit. Die sukses van so 'n fasiliteit sal grootliks afhang van die projek se vermoë om te verseker dat die benodigde aanvanklike belegging tot 'n minimum beperk sal word, en gevolglik sal die mees lewensvatbare droë hawe oplossing in die Wes-Kaap die gefaseerde ontwikkeling van Bellville gebied wees.

Hieruit is dit dus duidelik dat 'n droë hawe 'n haalbare alternatief vir die uitbreiding van die deurset kapasiteit van die Kaapstadse hawe, asook die verbetering van die vervoer-infrastruktuur in Kaapstad kan wees.

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Abbreviations and Acronyms

BNSF	-	Burlington Northern Santa Fe Railway
BRICS	-	Brazil, India, China and South Africa
Capecor	-	Western Cape Corridor
CD	-	Chart Datum
CES	-	Centralized Examination Station
CFS	-	Container Freight Station
COP	-	Conference of the Parties
CSCMUS	-	Centre of Supply Chain Management of the University of Stellenbosch
CSIR	-	Council for Scientific and Industrial Research
CY	-	Container terminal Yard
DWT	-	Dead Weight Tonnage
FTZ	-	Free Trade Zone
GDP	-	Gross Domestic Product
IDZ	-	Industrial Development Zone
NCEP	-	National Centres of Environmental Predictions
NS	-	Norfolk Southern
PIDN	-	Port Inland Distribution Network
PONYNJ	-	Port of New York and New Jersey
RMG	-	Rail-Mounted Gantry
RTG	-	Rubber-Tyre Gantry
SATS	-	South African Transport Services
SPARCS	-	Synchronous Planning and Real Time Control System

STS	-	Ship-To-Shore
SWAN	-	Simulating Waves Near-shore
TEU	-	Twenty foot Equivalent Unit
TNPA	-	Transnet National Ports Authority
TPT	-	Transnet Port Terminals
ULCV	-	Ultra-Large Container Vessels
UNESCAP	-	United Nations Economic and Social Commission for Asia and the Pacific
VIP	-	Virginia Inland Port
Wesgro	-	Western Cape Investment and Trade Promotion Agency

Chapter 1 Introduction

1.1 Outline

In maritime ports where large numbers of containers are handled, it is common to find that the throughput capacity at the maritime port is limited because of a lack of space adjoining the quay wall for storage of containers. By the creation of an inland area for storage of containers, a dry port, the throughput capacity of an existing maritime port can often be significantly improved. This thesis involves the investigation of the dry port concept for relief of congestion of container storage at the Port of Cape Town.

Containerized trade has become an integral part of the world, as well as the South African economy. The efficiency of containerized trade gives South African consumers access to imports and it also provides access to South African exporters to world markets.

The significant growth in global, as well as South African, container volumes has been a concern for the South African and the Western Cape Governments for many years and they encourage the improvement of infrastructure and efficiency of the South African transport system. Several government policies and reports directly mention intermodal transport and the improvement of maritime ports and transport infrastructure (refer to Chapter 6). These policies directly influence the Port of Cape Town, because the maritime port is the single biggest role player in the supply chain in the Cape Town metropolitan area and directly and indirectly influences all trade in the Western Cape.

The Port of Cape Town is the second biggest maritime port under the umbrella body of the Transnet National Port Authority (TNPA). The Port of Cape Town is strategically one of the best placed ports in South Africa as it is positioned at the South Western extremity of the continent of Africa, thereby linking America and Europe with Asia, the Far East and Australia. Furthermore, the Port of Cape Town also forms a direct link between international trade and about three (3) million consumers in the Western Cape.

The recent expansion of the Cape Town Container Terminal was a major investment which included the upgrading of equipment and the expansion of workable surface area, thereby increasing the container terminal yard capacity to 1.4million TEU (TEU = Twenty foot Equivalent Unit) per annum. However, the Centre for Supply Chain Management of the University of

Stellenbosch (CSCMUS) has created a model to study physical flows in South Africa and the forecast for the Port of Cape Town shows that in 2024 the demand for the Port of Cape Town should already reach 1 410 298 TEU, thus exceeding the CY capacity of the expansion project. The CSCMUS has also estimated that the demand will keep growing and should reach 2 462 000 TEU in 2039 (Centre of Supply Chain Management of the University of Stellenbosch , 2009).

Richer (2010) states that CY area appears to be the primary limiting factor to practical maritime port capacity, because large vessels exchanging a small proportion of their containers in Cape Town have prompted the maritime port and its container terminals to provide container berths that are adequate to accommodate the random nature of the vessel calls and their requirements for crane guarantees (It should however be noted that this statement was largely unsubstantiated and did not quantify the lack of CY area).

The main consequence of this lack of CY area is congestion in the maritime container terminal and ultimately the incapacity for the maritime port to accept as many containers as it should. Along with CY capacity, road congestion is the main challenge faced by the Port of Cape Town. The root of the congestion problem lies with the historic development of Cape Town and the fact that the growth of the city was directly related to the growth of the port. This resulted in the Port of Cape Town being surrounded by infrastructure that has not been nor could have been planned and built to accommodate the current freight- as well as commuter traffic growth rates.

The sixth edition (2009) of the annual State of Logistics Survey for South Africa report, published by the Council for Scientific and Industrial Research (CSIR), emphasizes the overuse of the South African road network and proves that the current South African transport model is not sustainable. One of the changes suggested by that report is that the congestion problem faced by the greater Cape Town area could be alleviated by the establishment of an integrated multimodal transport strategy. The aim would be to improve the throughput capacity of the maritime port, but also to resolve road congestion and improve circulation of goods and people.

At present, countries in North America and the European Union are placing great emphasis on solving these problems through the implementation of the dry port concept. The dry port concept includes the notion that some of the facilities at maritime ports could be duplicated or complemented at inland locations. Through this notion economic development and logistics integration are promoted and the demands on limited capacity (land and access) at the maritime ports are reduced. The influence of increased port-area land value and limited adjacent

warehousing/distribution facilities has made the concept of a dry port appealing for port authorities.

Therefore it is clear that a dry port could be a relevant solution to increasing the throughput capacity of the Port of Cape Town, as well as improving the transport infrastructure in the Cape Town area. By defining the concept of the dry port, describing important aspects of the dry port implementation analyses and looking for ways to make it an integral part of the ports supply chain, this report suggests and supplies knowledge for the transportation planners and policy makers when planning the future of the Port of Cape Town and this supply chain.

1.2 Objective

The core objective of this study is to demonstrate that the implementation of the dry port concept is a feasible alternative for expanding the throughput capacity of the Cape Town Container Terminal.

1.3 Definitions and Delineations

Several definitions can be found in literature; therefore the definition of a dry port suggested by this study is given below:

A dry port is an intermodal container terminal at a site displaced from maritime ports (outside the maritime port boundary) where transportation, warehousing and stacking capabilities, combined with value-added services, can facilitate and promote international trade, relieve maritime port congestion and enhance local, regional and national economic and social developments. Dry ports function in a similar manner to that of maritime ports and can be considered as an extension of the maritime ports. Dry ports are mostly container-oriented with a direct connection via rail and/or road to one or more maritime ports – as defined in section 2.3.1 of this study.

The need for the study does not arise from a single economic or transportation challenge but rather from the convergence of several challenges faced by the Western Cape container cargo industry, namely: an increasing globalization, capacity constraints within the Port of Cape Town as well as the surrounding transportation systems and rising transportation costs. It should be noted that this study does not aim to prove that the dry port concept is the only solution to these challenges, but rather to clarify the relevance of the dry port concept as a possible solution to these challenges and not discarding the fact that numerous other solutions exist.

1.4 Methodology and Structure of Study

The methodology of this study can be summarized as follows (refer to Figure 1):

- Identify previous studies done on the Port of Cape Town that have relevance to maritime port capacity and the dry port concept.
- Define the dry port concept, as well as identifying critical needs for the success of dry ports.
- Identify the status quo at the Port of Cape Town, to determine the issues it is facing.
- Identify the capacity limiting characteristics of the Cape Town Container Terminal.
- Determine the feasibility of increasing the capacity of the Cape Town Container Terminal through the implementation of a dry port in the greater Cape Town area.
- Identify possible future expansion options for the Cape Town Container Terminal, without increasing the overall marine footprint of the Port of Cape Town.

1.4.1 Literature review

The literature review gives an overview of previous studies done on the Port of Cape Town that have relevance to maritime port capacity and the dry port concept and thereby, highlights the current situation in the maritime port as well as provides the researcher with a better understanding of the possibility for the implementation of a dry port in the Western Cape supply chain.

An introduction to the dry port concept is given, defining the dry port concept, as well as describing the types of dry ports that exist, the factors that drive the emergence of a dry port and the functions of a dry port. Several examples of existing dry ports are also given as a basis for determining best practice guidelines. This provides valuable conceptual and practical knowledge of the dry port concept and how it can be applied to the Port of Cape Town.

Special attention is given to the capacity restrictions at the Cape Town Container Terminal to determine the limiting factor(s) in the maritime container terminal. The capacity limiting characteristics are determined in two ways. Firstly, an overview is provided on general design guidelines for container terminals, which will be used to determine the maximum capacity of the current maritime port infrastructure. Secondly, an overview is conducted on productivity and efficiency measures for container terminals, which will be used to determine the utilization of the current maritime port infrastructure. These two methods will enable the researcher to determine the current capacity limiting characteristics of the Cape Town Container Terminal.

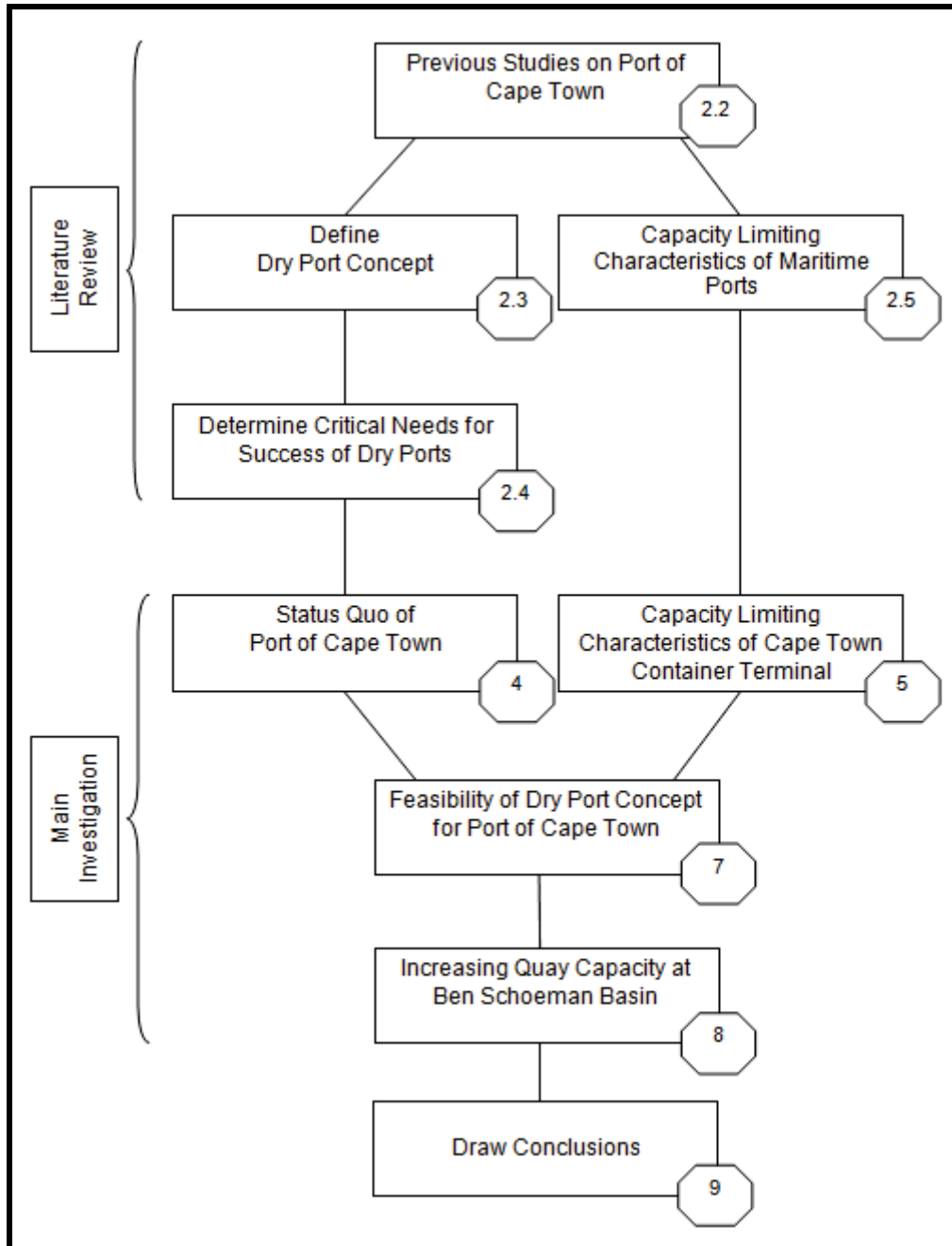


Figure 1: Methodology of Study

A brief analysis of port and terminal data sources is performed, which highlights the data sources and the data requirements to determine the capacity limiting characteristics, as well as the hurdles and constrains of available data.

1.4.2 Main investigation

The main investigation of the study starts with an overview of world containerized trade. This is done because of the fact that containerized trade forms the bulk of the merchandise that passes through the Port of Cape Town.

An outline of the Port of Cape Town is presented in terms of: the available facilities, current and future container volumes and inefficiencies at the maritime port. This highlights the current situation in the maritime port as well as provides the researcher with a better understanding of the possibility of the implementation of a dry port in the Western Cape supply chain.

The capacity limiting characteristics of the Cape Town Container Terminal are determined in two steps. Firstly, the maximum capacity of the current port infrastructure is determined by applying the general design guidelines for container terminals, which have been identified in the literature review. Secondly, the utilization of the current maritime port infrastructure is determined by making use of the identified productivity and efficiency measures for container terminals. These two steps enable the researcher to give a summary of the current capacity restrictions of the Cape Town Container Terminal.

Special attention is given to existing South African policies that have specific relevance to this study. The review of the policies is done to illustrate the willingness of all levels of government to expand and improve the supply chain.

A case study is done on the Cape Town Container Terminal to determine whether the dry port concept can be presented as a feasible solution to the previously identified capacity restrictions. The feasibility of the dry port concept is determined in three steps:

- firstly, identify the operational characteristics of the dry port concept;
- secondly, apply a site selection analysis to determine a potential location;
- finally, discuss the operational characteristics of the dry port as a part of the supply chain.

A review is made of possible future expansion options for the Cape Town Container Terminal, without increasing the overall seaside footprint of the Port of Cape Town. The review is conducted because of the fact that the dry port concept ensures that the CY area is no longer the capacity limiting factor of the maritime container terminal.

At this stage, the information and opinions gathered should be sufficient to draw conclusions on the implementation of a dry port in the Western Cape supply chain as well as recommendations for future developments and studies.

1.5 Reading Guide

The study comprises nine chapters, each with its own focus and objective (refer to Figure 1). Chapter 1 and Chapter 2 give a brief overview of the study by stipulating the objective, methodology and structure of the said study, as well as presenting the literature review that provided guidance for the researcher throughout this study.

Chapter 3 and Chapter 4 present an overview the Port of Cape Town in terms of global containerized trade, available facilities, current and future container volumes and inefficiencies at the maritime port. The information presented in these chapters is used in Chapter 5 to identify the capacity limiting characteristics at the Cape Town Container Terminal.

Chapter 6 and Chapter 7 provide an overview of South African policies that have specific relevance to the dry port concept and present the dry port concept as a solution to the capacity restrictions in Cape Town, which were identified in Chapter 5.

Chapter 8 identifies possible future expansion options for the Cape Town Container Terminal, without increasing the overall seaside footprint of the Port of Cape Town, and Chapter 9 conclude the study, bringing together all the elements of this study.

Chapter 2 Literature Review

2.1 Introduction

The following section presents a review of the literature that provided the researcher with guidance throughout this study and focuses on the following areas:

- previous studies that have been done on the Port of Cape Town that have relevance to maritime port capacity and the dry port concept;
- the dry port concept with emphasis on: definition, types, driving factors and functions;
- existing dry ports and the key factors that contributed to the success or failure of these dry ports;
- capacity limiting characteristics of maritime ports;
- maritime port and terminal data sources.



Figure 2: Port of Cape Town (Burgraaf, 2010)

2.2 Port of Cape Town

The following sections provide an overview of previous studies done on the Port of Cape Town that have relevance to port capacity and the dry port concept. The overview highlights the current situation in the port as well as provides the researcher with a better understanding of the feasibility of the implementation of a dry port in the Port of Cape Town's supply chain.

A study done by Van Dyk & Maspero (2004) provides background on the South African fresh fruit industry and its export supply chain as well as an overview of the logistics infrastructure (including the Port of Cape Town) used by the South African fruit industry.

Meyer (2010) conducted a study with the aim to determine if and when a need will exist for the development of an additional hub port in South Africa. The author stated that the trade between India, Europe and South America were growing, which provides the Port of Cape Town with the strategic advantage of becoming a hub port in South Africa. However, the study noted that this would only be possible if the South African shipping industry provided an efficient and cost effective alternative to current trade routes.

Olivier (2012) studied the inefficiencies that exist within the South African container shipping industry. The author mainly focused on the Cape Town region and identified the following inefficiencies:

- information integrity;
- access to the hinterland;
- vessel congestion at port;
- percentage of cargo being transported on rail.

The author stated that a lot of these inefficiencies cannot be eliminated by a single organisation, but require the cooperation of all the parties in a supply chain.

Richer (2010) identified key success factors for the implementation of a dry port (author used the term inland port) at Cape Town. The author noted that along with capacity, the maritime port is facing other issues such as low productivity, poor infrastructure and congestion in the maritime port area. Furthermore, the author stated that the dry port has to bring solutions to these issues in the following ways:

- Capacity must be addressed with a large piece of land that can accommodate growing volumes and also large investment in equipment and training to increase the productivity and therefore the throughput of the supply chain;
- In order to decrease congestion in the maritime port area, the dry port has to be located out of the city in an area that can sustain growing traffic.

The author concluded by saying that a dry port presents a major opportunity to develop intermodal transport for a more sustainable transport system in South Africa. It should however be noted that the findings of this study were largely unsubstantiated and did not quantify the lack of CY area nor the feasibility of the dry port concept.

2.3 Dry Ports Theory

The following section provides an introduction to the dry port concept, defining the dry port concept, as well as describing the types of dry ports that exist, the factors that drive the emergence of a dry port and the functions of a dry port. Several examples of existing dry ports are given as a basis for determining best practice guidelines. Thereby, providing valuable conceptual and practical knowledge of the dry port concept and how it can be applied at the Port of Cape Town.

2.3.1 The Dry Port Concept Defined

The dry port is a rather new concept and different definitions are used to describe the concept. It is, therefore, necessary to review existing dry port definitions and analyze dry port characteristics to describe the features differentiating a dry port from other inland container terminals. Furthermore, when defining a concept one needs to be wary of the fact that regional variation of definitions exist. Different terminology may be used to describe the same terminal type, and the same expressions may be used to describe different facilities (Trainaviciute, 2009).

Jones Lang LaSalle (2011) uses the term inland port to describe the dry port concept. The author states that inbound cargo will increasingly be transferred directly from an ocean vessel to railcars and then transported to an inland location, away from the more congested maritime port itself, for further processing and distribution. The author stresses that the location of these dry ports are becoming increasingly critical to the global supply chain and will affect logistics decisions ranging from shipping routes to warehouse locations. A similar definition is provided by Leitner & Harrison (2001).

Jones Lang LaSalle (2011) articulates that not all inland container terminals are dry ports and that only inland container terminals with the following characteristics can be considered to be dry ports:

- market proximity to at least three (3) million people within 320km;
- availability of a direct connection to a maritime port via a transportation system;
- the status and privileges of a Free Trade Zone (FTZ);
- an abundance of reasonably priced commercial real estate for warehousing;
- a provincial and national government climate that is enthusiastic about dry port development, and willing to offer strong incentives to participants.

The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP, 2006) defines the term dry port as follows: dry port refers to a defined inland location for the consolidation and distribution of goods that have functions similar to those of a maritime port and which includes customs clearance services. Maritime port functions that could be expected to be typically present at these dry ports include container (and possibly bulk) handling facilities; intermodal infrastructure connections; a geographical grouping of independent companies and bodies dealing with freight transport; and the provision of accompanying services such as customs inspections, tax payment, storage, maintenance and repairs, banking and information communication technology connections.

Piyapatroomi, Bunker and Ferreira (2006) and Gronalt, Benna and Posset (2008) provide similar definitions and describe the dry port concept as an inland container terminal that is designed to provide seamless transfer of goods from one mode of transport to another. The authors stress that, although the dry port can be situated at different locations, the purpose of the dry port will remain the same.

Tsilingiris and Laguardia (2007) and Trainaviciute (2009) both describe the dry port concept as an inland container terminal that is directly connected via rail and/or truck to one or more maritime ports, which can substitute certain maritime port services in certain areas. The authors stress that the main aim of establishing a dry port is to perform certain container handling operations that have undesirable temporal and financial implications when done at a congested maritime port.

Rahimi, Asef-Vaziri & Harrison (2008) describe the dry port concept as an inland port which can be defined as clusters of distribution and logistics centres located on a transportation corridor

and that the presence of multi-modal infrastructure at dry ports provides the opportunity to reduce inefficiencies, particularly when value-added services are present.

Smith (2010) uses the term inland port to describe the dry port concept and defines a dry port as a facility or organization that process and handles shipments at a site displaced from the maritime ports. The author goes on to state that the dry port concept refers to the idea that some maritime port facilities could be duplicated or complemented at inland locations, thus promoting economic development and logistics integration inland, while reducing the demands on scarce space at the maritime port. In conclusion the author articulates that the distinguishing feature of a dry port is the use of transportation assets as an anchor tenant for logistics-based economic development.

From the definitions that were reviewed it can be concluded that they all stress the similarity between the operating functions and the transshipment functions of a dry port and a maritime port. Further to this it can be concluded that the definition and role of dry ports continue to evolve, as dry ports are being considered as extensions of maritime ports where expansion of maritime ports are limited by cost, environmental issues and congestion.

The definition of a dry port suggested by this study is given below:

A dry port is an intermodal container terminal at a site displaced from maritime ports (outside the maritime port boundary) where transportation, warehousing and stacking capabilities, combined with value-added services, can facilitate and promote international trade, relieve maritime port congestion and enhance local, regional and national economic and social developments. Dry ports function in a similar manner to that of maritime ports and can be considered as an extension of the maritime ports. Dry ports are mostly container-oriented with a direct connection via rail and/or road to one or more maritime ports.

2.3.2 The Functions of Dry Ports

The dry port concept includes the notion that some of the facilities at traditional maritime ports could be duplicated or complemented at inland locations. Through this notion economic development and logistics integration are promoted and the demands on limited capacity (land and access) at the maritime ports are reduced. The influence of increased maritime port-area land value and limited adjacent warehousing/distribution facilities has made the concept of a dry port appealing for port authorities.

The three main objectives of a dry port are international trade processing, congestion relieve and regional development. International trade processing and congestion relieve are achieved through the consolidation of services, which makes a dry port more attractive to shippers and logistics managers concerned with promoting efficient supply chains. Furthermore, regional development is accomplished by providing jobs in the direct processing of international trade and attracting distribution and manufacturing industries to the region, which is critical to gain community support for the project.

The above implies that, for a dry port to realize these objectives it needs to be able to perform the following functions:

- **Processing:** gives the dry port the opportunity to increase the value of the cargo it handles by providing the following functions: refining, sorting, packaging, testing and assembling (The Tioga Group, Inc., 2006);
- **Consolidation:** allows the dry port to combine multiple small shipments into a single, more efficient, large shipment, as well as to combine multiple items into a single delivered product (The Tioga Group, Inc., 2006);
- **Distribution:** enables the dry port to split large shipments into smaller shipments for local delivery;
- **Transshipment of cargo between different transportation modes:** requires the dry port to have special equipment for the transfer of units from one mode to another. Furthermore, it allows the dry port to consolidate the goods from different shippers and transport it further to the maritime port by rail. This promotes rail traffic, which leads to significant environmental benefits (Trainaviciute, 2009);
- **Storing and empty container supply:** the storing of goods can include long and short term storing, where short term storing is used when goods are transhipped and long term storing is used for distribution and empty container storage services. The storing services are vital for a transportation network, because it regulates the imbalance in container flows (Trainaviciute, 2009);
- **Customs inspections:** is one of the most important special services that a dry port provides. When inspections are done in a dry port instead of the maritime port, the waiting time is reduced in the maritime port, which reduces congestion. However, it should be noted that a number of safety/security considerations need to be taken into account if this operation is to be performed at inland locations. The following is included in this function: firstly, Centralized Examination Station (CES) is essentially a warehouse

where Customs and Border Protection agents can have access to the goods in question. Secondly, in-bond transport is when a bond is posted on cargo and the cargo is transported in-bond to an inland location pending customs clearance;

- **FTZ:** is a site where foreign and domestic goods are considered to be outside of the country's customs territory.

2.4 Types of Dry Ports

The dry port concept can further be defined by dividing dry ports into different categories. The researcher found that this was necessary because not all sites follow the same model of development. It became apparent to the researcher that sites can fall into different categories, but still adhere to the definition of a dry port (defined in section 2.3.1).

Four basic categories of dry ports were identified to guide the research for this study.

- A satellite marine terminal dry port, with the primary function of providing a consolidation or deconsolidation point for goods being shipped in or out of a congested maritime port;
- An import distribution dry port, with the primary function of handling loaded imported containers;
- An export transload dry port, with the primary function of handling loaded exported containers;
- An integrated logistics park dry port, with integrated operations encompassing both import and export functions along with container storage.

2.4.1 Satellite Marine Terminal Dry Port

The satellite marine terminal dry port concept can be classified as the original dry port, because the concept aims to replicate the key commercial and operational functions of a maritime port at an inland location, thus providing a consolidation or deconsolidation point for goods being shipped in or out of a congested maritime port. The location of the terminal supports fast delivery to the maritime port, but also relieves congestion by shifting traffic away from the highways serving the maritime port. The terminal is typically connected to the maritime port through a dedicated high- or railway, on which the cargo movement takes place under the steamship bill of lading (Smith, 2010). The most successful satellite marine terminal dry port in the United States is the Virginia Inland Port (VIP), refer to section 2.6.2.

The Tioga Group Inc. (2006) suggests that the development of a satellite marine terminal dry port can be considered as best practice if a dry port is required to enable the maritime port to expand its CY area and increase the efficiency of on-dock operations.

2.4.2 Import Distribution and Export Transload Dry Ports

The import distribution dry ports as well as export transload dry ports are both a specialized form of a satellite marine terminal dry port, focused on handling loaded imported and loaded exported cargo, respectively. The origin of these dry ports came from the increase of land prices close to the maritime ports. The increase in land prices forced logistics firms to relocate further away from the maritime ports, which in turn increased the distance required for drayage from the port and raised public concern over both traffic congestion and air quality impacts.

The IBI Group Inc. (2006) suggests that the development of these dry ports can be considered as best practice when:

- **Import Distribution Dry Port:** A dry port is required to relieve the maritime port from congestion caused by imported cargo. The authors emphasize the fact that import distribution dry ports can only succeed if the existing import demand can presuppose a sufficient scale of operation and that the import demand is directly proportional to the size of the local market.
- **Export Distribution Dry Port:** A dry port is required to relieve on-dock congestion and delays caused by exported cargo. The efficiency of the maritime container terminal is optimized because the consolidation and sorting of cargo to be exported are done at an inland location away from congested maritime terminals.

2.4.3 Integrated Logistics Park Dry Port

The integrated logistics park dry port concept is a relatively new phenomenon in North America, but it has a longer history in Western Europe, where it has been used since the 1970's. The origin of the integrated logistics park dry port came from the industrial parks concept, where industrial organizations find corporate homes in a single location.

The integrated logistics park dry port concept was defined by Gooley (1997) and HDR Engineering Inc. (2006) as regional hubs that offer shippers a complete range of domestic and international transportation and distribution services that bring together, in one location, all the

modes of transportation, along with warehousing, freight forwarding and customs brokers and logistics-management services.

The aim of this all-in-one concept is to provide the following transportation advantages to companies (HDR Engineering Inc., 2006):

- optimization of the logistics chain, truck utilization, warehouse utilization and labour force resources;
- a decrease in logistics, transport and personnel costs;
- an increase in the volume of freight transported.

The IBI Group (2006) suggests that the development of an integrated logistics park dry port can be considered as best practice if a dry port is required to provide the critical mass for optimizing transportation and distribution activities while minimizing the external impacts such as road congestion, noise and emission on surrounding communities. The City Deep Container Complex is a prime example of an integrated logistics park dry port (refer to section 2.6.3).

2.4.4 Secondary Classification

As previously discussed, dry ports can be divided into four types. However, the researcher found that these four types can be seen as a primary classification of dry ports and that a secondary classification is needed to understand the overall functionality of a dry port. Roso et al. (2006) proposes that a secondary classification of dry ports can be made according to the distance that the dry port is situated away from the maritime port. The author suggests that dry ports can be divided into the following:

- **Distant Dry Ports:** The establishment a dry port at a large distance (over 500 km) away from a maritime port is practical if this location is situated near large areas of consumption and manufacturing. At this distant location the dry port has a strategic advantage and can potentially attract large volumes of cargo. The distant dry port concept has the advantage that all the cargo, from different shippers, arrives at the maritime port by rail, which reduces congestion on the access routes to the maritime port (Trainaviciute, 2009).
- **Close and Midrange Dry Ports:** The purpose of close (the distance from the port is around 50 km or less) and midrange (the distance from the port is around 70 km to 500 km) dry ports is to consolidate road transport to and from shippers outside the city area by offering a rail shuttle service to the maritime port, thus relieving the city streets and the maritime port gates. According to Trainaviciute (2009) the establishing of a close or

midrange dry port can be considered as best practice if the maritime port lacks adequate CY area and its capacity cannot be increased, especially when the maritime port cannot expand due to inhabited surrounding areas or environmental aspects.

2.5 Factors Driving the Emergence of Dry Ports

Currently maritime ports experience congestion, pollution and other logistics-related problems due to increasing levels of traffic. The presence of these problems has caused port planners, port operators and logistics firms to look for new solutions in the transport sector. The new solutions need to be able to prevent bottlenecks, mitigate environmental problems and be flexible enough to adapt to an ever changing economic climate. The dry port concept is recognized as a means for solving some of these major problems.

2.5.1 Maritime Port Congestion

The economical growth and increasing flow volumes of goods are causing intensive maritime traffic, which in turn causes certain maritime port functions, such as container sorting, to become inefficient. These inefficiencies can dramatically reduce the operating capacity of a maritime port, thus aggravating the congestion problems. Furthermore, the recent advances in container vessel technology, dramatically increasing container vessel sizes and the expected opening of the expanded Panama Canal in 2015 will increase the demand maritime ports. Therefore a number of maritime ports are facing challenges related to the lack of capacity or efficiency.

The University of Turku carried out a survey in which it was revealed that the biggest bottlenecks for the growth and development of Baltic maritime ports were inadequate CY area and the lack of expansion areas (Trainaviciute, 2009). The bottom line of this survey is that the maritime ports are not expanding quickly enough to be able to cope with the ever growing demand.

The incorporation of dry ports into the transportation network is an opportunity for the maritime port to expand its CY area into the inland areas, further away from the water and hereby addressing capacity and efficiency constraints. The dry port enables the maritime port to increase the speed that freight is sent out from their territory, thus postponing the need for a new maritime container terminal when the maritime port reaches its capacity.

2.5.2 Road Congestion

At present an imbalance in transport modes exists world-wide, with more than 75% of American and European domestic freight being conveyed by road transportation. The world-wide success of road transportation has resulted in significant road congestion and environmental problems. According to Roso et al. (2006) road congestion has major secondary impacts on social and environmental cost, such as loss of time, additional vehicle maintenance cost, indirect health effects and stress. The problems are most acute in areas with high levels of economic activity, typically where maritime ports are located.

Further to this, significant improvement of the waterside equipment in some maritime ports has led to significant increases in efficiency of waterside operation. These improvements have resulted in additional pressure on hinterland connections, which has an impact on the efficiency and reliability of freight flows and thus on the prices of the goods that are carried. It is consequently clear that a shift from road to other transport means has to be made in order to facilitate efficient transportation and to reduce road congestion.

The incorporation of dry ports into the transportation network is an opportunity to facilitate the shift from road to rail transportation because the economics of long- and short-haul rail shipping are steadily improving and rail is a far more sustainable mode of transportation, producing 40% to 60% less carbon emissions than road transportation (Sea Freight Council of New South Wales Inc., 2004).

2.5.3 Environmental Problems

Globally the effect of global warming and greenhouse gases is becoming more and more evident and during the 17th Conference of the Parties (COP) the need to reduce these effects was highlighted. At this conference the road transportation sector was identified as one of the main contributors to local and global environmental problems. The road transportation sector contributes to local air pollution by emitting several air pollutants of which carbon dioxide is the main contributor.

In addition to global warming the port infrastructure and operations are harmful to the environment as it can interfere with the original ecological systems and alter the hydrological processes. These harmful operations include dredging of sea floors to deepen shipping channels and port infrastructure expansion. Therefore to prevent negative environmental effects maritime port infrastructure expansion at the water should be limited.

The incorporation of dry ports into the transportation network is an opportunity to facilitate the shift from road to rail transportation and to avoiding the expansion of the maritime ports infrastructure by the waterside.

2.6 Existing Dry Ports

The following section of the study gives a broad overview of existing dry ports. The researcher found that many entities promoting specific sites currently claim dry port status but generally do not shed valuable information on this subject. Therefore, only dry ports that adhere to the definition of a dry port (defined in section 2.3.1) and add value to this study were included in this section.

The description of existing dry ports was done to assist the researcher in identifying the key factors that contribute to the success or failure of these dry ports. The critical factors needed for the success of the dry ports is then summarized and will be used to justify the critical needs for the success of a dry port identified in Chapter 7.

The following North American dry ports were reviewed by this study:

- Virginia Inland Port (VIP), Front Royal, Virginia, United States of America (refer to 2.6.2);
- Alliance Texas, Dallas, Texas, United States of America (refer to Appendix A);
- California Integrated Logistics Centre, Shafter, California, United States of America (refer to Appendix A);
- Port Inland Distribution Network (PIDN), Port of New York and New Jersey (PONYNJ), United States of America (refer to Appendix A);
- Albany Barge Service, New York, United States of America (refer to Appendix A);
- Vancouver Inland Terminal, Vancouver, Canada (refer to Appendix A).

The following international dry ports were reviewed by this study:

- Metroport, Auckland, New Zealand (refer to 2.6.1);
- Associated British Ports Connect, Hams Hall Birmingham, United Kingdom (refer to Appendix A);
- Coatbridge Freight Liner Terminal, Coatbridge, Scotland (refer to Appendix A);
- Logport, Duisburg, Germany (refer to Appendix A);
- Puerto Seco de Madrid, Madrid, Spain (refer to Appendix A);
- Central Euro-Asia Gateway, Jekabpils, Latvia (refer to Appendix A).

The international dry ports that were studied operate with similar concepts as sites in North America, but their international trade processing differs. For instance the trade at the European sites is enhanced and simplified by the existence of the European Union where as the New Zealand sites operate in a uniform manner because New Zealand is an island nation and all international trade arrives by sea or air.

The following South African dry ports were reviewed by this study:

- City Deep Container Complex, Gauteng, South Africa (refer to 2.6.3);
- Tambo Springs Terminal, Gauteng, South Africa (refer to 2.6.4).

2.6.1 Metroport, Auckland, New Zealand

Metroport Auckland was established in 1999 and is New Zealand's first officially termed dry port. Metroport is located (refer to Figure 3) in South Auckland's manufacturing region approximately 224km away from the Port of Tauranga and is directly linked to the maritime port via a rail service operated by Kiwi Rail (The Tioga Group, Inc., 2006).

Metroport's main focus is landside container flow, which is complemented by the fact that the facility is a customs bonded site, implying that imported containers do not undergo customs clearance at the Port of Tauranga. The customs transactions take place at the inland location of Metroport. The same operating procedure is used for agricultural goods that pass through the dry port.

The Port of Tauranga is New Zealand's fastest growing port, but has increasing competition from the Port of Auckland. The key for the Port of Tauranga to maintain its competitive position is to provide an efficient way to deliver the containers from Tauranga to Metroport in Auckland. This is done by ensuring that the truck turnaround times at Metroport are the lowest in the Auckland market with an average turnaround time of 15.6 minutes (Port of Tauranga, 2011).



Figure 3: Location of Metroport (Port of Tauranga, 2011)

Metroport currently operates on 3.5 hectares with 1 450 ground slots and has an annual throughput of 168 000 TEU. Metroport has twin dedicated rail sidings at 780 meters that can cater for unit trains of 110 TEU. The trip from Metroport to the Port of Tauranga takes approximately four (4) hours on the main north-south trunk rail line in New Zealand (Leitner & Harrison, 2001).

Metroport is an extension of the Port of Tauranga's commercial presence in the Port of Auckland's market. In this way Metroport's situation is similar to that of the VIP relative to the maritime ports of Norfolk and Baltimore (refer to section 2.6.2). This implies that the reason for Metroport's origin is neither to reduce truck travel nor to improve system efficiency, but rather a commercial initiative. The Port of Tauranga has traditionally been export driven, but through the commercial initiative, that is Metroport, the port has successfully grown its share in the Auckland import market.

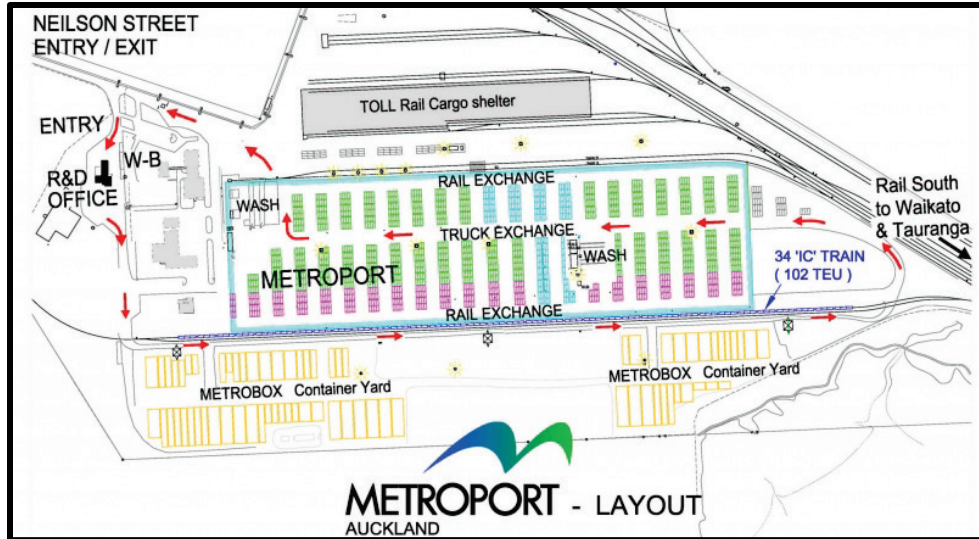


Figure 4: Layout of Metroport, Auckland (Port of Tauranga, 2011)

From the review of the Metroport facility the following factors were identified for the success of a dry port:

- **Volume:** the Port of Tauranga is New Zealand's fastest growing maritime port, which produces the cargo volumes needed for cost effective operation of the dry port;
- **Access to transportation infrastructure:** Metroport has a direct rail connection to the Port of Tauranga, which ensures efficient cargo flow;
- **Distance:** the location of the dry port, 224km away from the Port of Tauranga, enables the rail service to compete with road transportation.

2.6.2 Virginia Inland Port, Front Royal, Virginia

The VIP started its operation in 1989 and is located in Front Royal, Virginia, 350km inland from the Hampton Roads marine container terminals (Leitner & Harrison, 2001). VIP had its origin thanks to an effort to create time and monetary savings for shippers and container lines using the Ports of Virginia, by essentially bringing the marine terminals 350km closer to the target markets of the Northern Shenandoah Valley, West Virginia and the Southern Ohio Valley. VIP's location ensures that it is strategically positioned to attract and intercept container traffic that is trucked to other competing East Coast maritime ports.



Figure 5: Location of the VIP (Leitner & Harrison, 2001)

Originally VIP's main purpose was to capture a larger market share for the Port of Virginia (Norfolk), by capturing the cargo from the Ohio Valley that was primarily being exported through the Port of Baltimore. Further to the capturing of cargo the market expansion would also ensure that shipping lines add Norfolk to their schedules or to increase their business in Virginia.



Figure 6: Layout of the VIP (The Tioga Group, Inc., 2006)

Currently, VIP has developed about half of the sixty (60) available hectares and has access to 5 400m of on-site rail facilities operated by Norfolk Southern (NS) (Leitner & Harrison, 2001). NS provides VIP with a direct rail link to the marine terminals in Hampton Roads, which

operates five days a week. Further to the rail connection, VIP also has sufficient road access, which is essential because the majority of VIP's cargo arrives or departs by truck from or to the target market. The facility is a United States customs-designated port of entry with a full range of customs functions, which enables trucking companies to reduce the costs associated with importing cargo into the United States markets. The fast connection to the maritime ports and the customs functions have attracted more than twenty four (24) major manufacturing and distribution companies into the region, which actively take advantage of the port to ship a variety of products overseas, including plastics, medical supplies, apparel, auto parts, furnishings, food, paper and four-wheel-drive vehicles. The presence of these companies has stimulated the regional economy and it is estimated that 95% of the business generated by the VIP is new business for the Port of Virginia-Hampton Roads. The new business generated by these companies has resulted in nearly \$600 million in private sector capital investments (The Tioga Group, Inc., 2006).

From the review of the VIP the following factors were identified for the success of a dry port:

- **Initial Investment:** the project started with sufficient capital and commitment to develop the facility. The commissioning of facility was driven by the Commonwealth of Virginia to develop its maritime ports. The facility was constructed with money entirely from a Trust Fund created by citizen advisory commission and did not require any borrowings;
- **Synergy:** the Marketing Plan was viable and flexible enough to accommodate change. While the original target market was to capture the Ohio Valley cargo, the market that has emerged is based on improved transportation access to the region and its impact on the local economy;
- **Synergy and Initial Investment:** the synergy is evident from the longstanding and symbiotic relationship between NS and the Virginia Port Authority which supported the development of VIP. Both parties made a commitment to run the train link and absorb the train operating cost even during the long start up period.

2.6.3 City Deep Container Complex, Gauteng, South Africa

The city of Johannesburg is approximately 600km from the coast and lies in the province of Gauteng, which is the commercial centre of South Africa (refer to Figure 7). Johannesburg is the largest city in Sub-Saharan Africa and is situated close to South Africa's capital, Pretoria. Despite the fact that the areas surrounding Cape Town, Port Elizabeth, East London, Durban

and Richard's Bay are considerably industrialized, nearly 70% of South Africa's freight cargo are destined for, or originates in, the Gauteng area.

The City Deep Container Complex was developed in 1977 as a dry port for the import and export traffic through the ports of Durban, Cape Town, Port Elizabeth and East London. The City Deep Container Complex allows inbound containers to be transported directly to Gauteng, where customs clearance can take place. The City Deep Container Complex comprises of the Container Depot (the epicentre of this dry port facility), the Johannesburg Fresh Produce Market, the abattoir, manufacturing businesses, about seventeen (17) trucking and transport businesses and Kaserne.

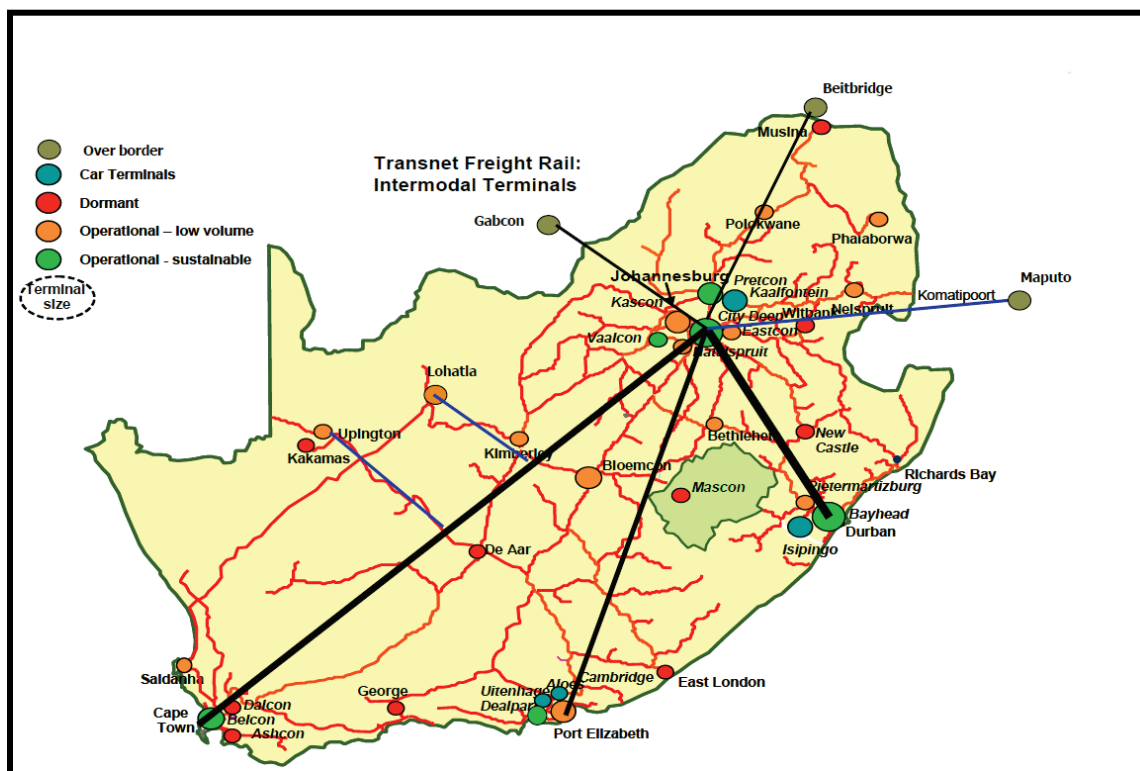


Figure 7: Location of City Deep and other Freight Rail Terminals (Transnet Limited, 2011)

The City Deep Container Complex handles approximately 310 000 TEU per annum and by 2020 this number is expected to increase to 0.5million TEU (ITS Engineering (Pty) Ltd., 2009). This complex forms the largest dry port in Africa (Keightley-Smith, 2011).

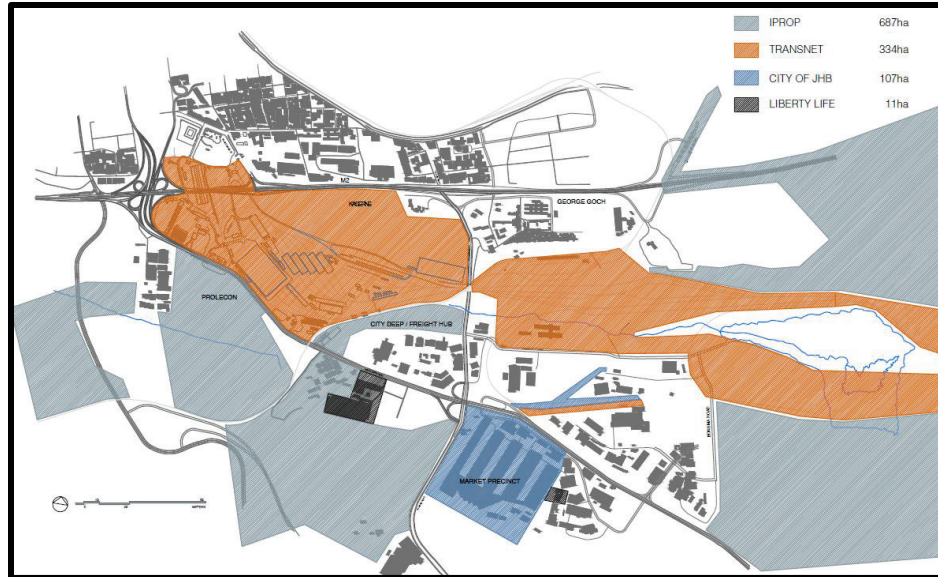


Figure 8: Layout of the City Deep Container Complex (Keightley-Smith, 2011)

From the review of the City Deep Container Complex the following factors were identified for the success of a dry port:

- **Distance:** the City Deep Container Complex located approximately 600km away from the coast, which enables the rail service to compete with road transportation;
- **Location:** the City Deep Container Complex is situated in Johannesburg, which is the largest city in Sub-Saharan Africa and is close to South Africa's capital, Pretoria (Tshwane).

2.6.4 Tambo Springs Terminal, Gauteng, South Africa

Tambo Springs Terminal is a new dry port and logistics gateway that has the aim to service Gauteng and the rest of Southern Africa. This dry port will be developed by the Cape Town based property developer, Inframax Holding, over a period of ten years and the development of the first phase was started in 2012. The facility will operate in close cooperation with the City Deep Container Complex, which is located 22km from the Tambo Springs Terminal.

The 630 hectare facility is situated 25km south-east of the Johannesburg central business district and within the Johannesburg-Durban road and rail freight corridors (Tambo Springs Development Co. (Pty) Ltd, 2013). This facility will have fast and easy access to South Africa's major road and rail networks, namely access to the N3 freeway to Durban, the N1 freeway to Cape Town and the R390 to Port Elizabeth and East London.

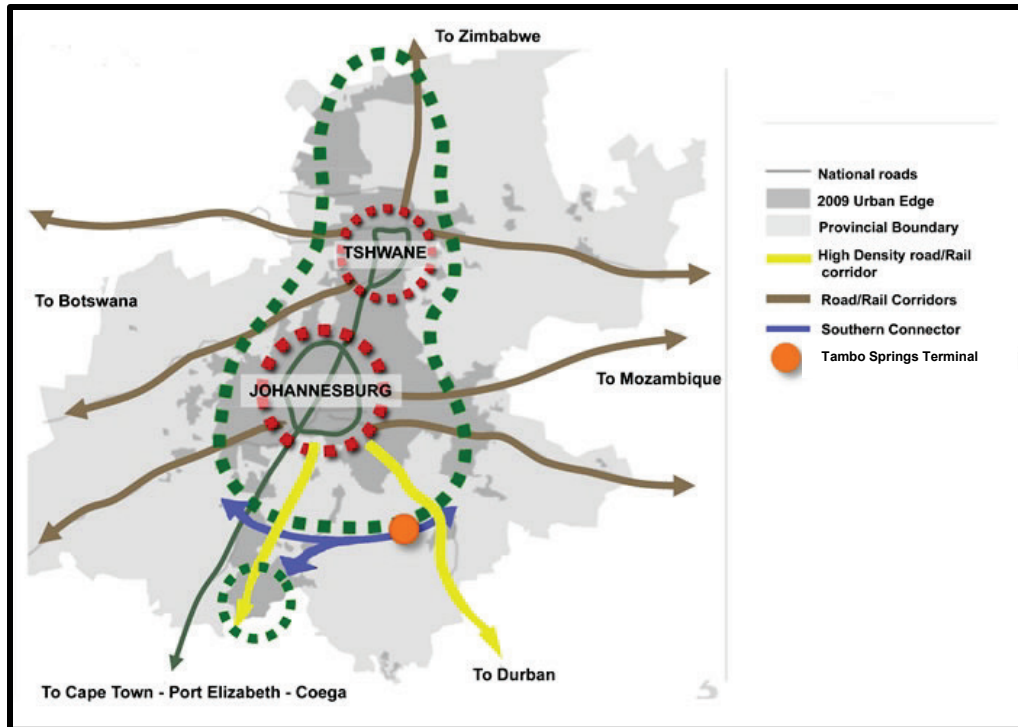


Figure 9: Location of Tambo Springs Terminal (Tambo Springs Development Co. (Pty) Ltd, 2013)

The Tambo Springs Terminal will enable the operators to accommodate point-to-point movement of freight, using block trains of up to 2km in length and to integrate the exchange of goods to and from the trains with road and air transportation systems.

According to Tambo Springs Development Co. (Pty) Ltd. (2013) the facility will nearly double current freight logistics capacity in and out of Johannesburg to 3million TEU by 2015 and to 4million TEU by 2020. Furthermore, the facility is expected to create new business and job opportunities as well as to enhance the gross domestic product (GDP) of Gauteng.

From the review of the Tambo Springs Terminal the following factors were identified that could possibly lead to the success of the proposed dry port:

- **Synergy:** Tambo Springs Terminal is a private-sector-driven initiative, Inframax has, from the outset, engaged key public-sector authorities and agencies to canvass in-principle policy support for the initiative (Tambo Springs Development Co. (Pty) Ltd, 2013);
- **Access to transportation infrastructure:** the Tambo Springs Terminal has fast and easy access to South Africa's major road and rail networks, namely: access to the N3 freeway

to Durban, the N1 freeway to Cape Town and the R390 to Port Elizabeth and East London.

- **Location:** the Tambo Springs Terminal is situated 25km south-east of the Johannesburg central business district and within the Johannesburg-Durban road and rail freight corridors.

2.7 Critical Factors needed for the Success of Dry Ports

The investigation of various dry ports around the world has identified several factors that need to be in place for a dry port to be successful:

- **Synergy:** from the studied dry ports it was clear that synergy played a major role in the success of all the projects. The dry port needs to be a commercial initiative. The concept of a dry port being a commercial initiative has successfully been adopted by Metroport, VIP and Central Euro-Asia Gateway. Using Metroport as an example: The Port of Tauranga has traditionally been export driven, but through Metroport, the maritime port has successfully grown its share in the Auckland import market. In this way Metroport's situation is similar to that of the VIP relative to the maritime ports of Norfolk and Baltimore. The planners and designers of a dry port need to be aware of, and understand that each dry port has unique challenges and opportunities which should be fully understood before the start of a project. The Associated British Ports Connect project identified that the dry port operators have to be directly involved in the design process from the start, to avoid "gold-plating" of the dry port design. The operation and marketing plans of the dry port have to be viable and flexible enough to accommodate change. VIP and Alliance Texas have both identified that flexibility has been the key to their success. Using VIP as an example, the original target market was to capture the Ohio Valley cargo, but the market that has emerged is based on improved transportation access to the region and its impact on the local economy. The dry port operator, developer and the national authority all need to make a long term commitment. The criticality of a long term commitment was identified by VIP (a successful dry port) and Albany Barge Terminal (a failed dry port identified synergy in lessons learned, refer to Appendix A). Using VIP as an example, the presence of a longstanding and symbiotic relationship between NS and the Virginia Port Authority supported the development of VIP. Both parties made a commitment to run the train link and absorb the train operating cost even during the long start up period;

- **Initial Investment:** for a dry port to be viable it is important to limit and control initial capital cost. Logport identified that initial capital cost can be minimized by using Brownfield sites with pre-existing road and rail access. Another way of reducing initial capital cost is to implement a phased development approach, provided the initial design does not preclude phased development.
- **Access to transportation infrastructure:** the dry port has to have access to multimodal connections. Nearly all the studied dry ports identified the need for multimodal connections. Using Logport as an example: the availability of multimodal connections such as the German Autobahn system and the InterCityExpress and InterCity long-distance networks of the Deutsche Bahn (German National Railway) have all contributed to the success of Logport.
- **Distance:** many of the studied dry ports had sufficient distance between the dry port and the maritime port for rail transportation to be able to compete with road transportation. A good example is Puerto Seco de Madrid, which provides the customers with long distance transport services which are reliable, high quality and relatively inexpensive. Furthermore, there is increasing pressure on the transportation sector to reduce its carbon footprint. The dry port concept gives the transportation sector the opportunity to reduce the risk of road congestion by providing a rail connection and therefore reducing its carbon emissions.
- **Location:** the dry port needs to be located in the epicentre of the market catchment area and has to provide the customers with value-added services of which customs clearance is the most important. Furthermore, the dry port needs to be located far enough away from congested maritime port areas to be able to provide sufficient space for initial and future warehousing and distribution facilities.
- **Volume:** for a dry port to be viable it needs to be located in a cargo catchment area that generates sufficient demand to be able to create the economies of scale needed for cost effective operations. A large enough catchment area was present at all of the successful dry ports that were studied.

These critical factors which are essential for the success of the dry ports were used to justify the critical needs for the success of a dry port identified in section 7.3 of this study. Although seasonality was not identified from the review of existing dry ports, it is still relevant to this study, due to the fact that the Western Cape market contains agricultural and horticultural

products that may experience seasonal fluctuation, which could have serious implications on the viability of a dry port.

2.8 Capacity Limiting Characteristics of Maritime Ports

This section of the study gives an overview of the information needed to determine the capacity limiting characteristics of a maritime port. The overview firstly focuses on general design guidelines and secondly on productivity and efficiency measures for maritime and dry port container terminals. The identified guidelines and measures enabled the researcher to evaluate the throughput capacity and equipment utilization of the current maritime port infrastructure as well as to determine the size characteristics of possible dry port facilities.

2.8.1 General Design Guidelines

The following section provides an overview of general design guidelines for maritime and dry port container terminals. The design guidelines were reported by Thoresen (2010) and Ligteringen & Velsink (2012) and enabled the researcher to determine the maximum capacity of the current maritime port infrastructure (refer to section 5.3), as well as to determine the size characteristics of possible dry port facilities (refer to section 7.5).

2.8.2 Design Guidelines – Design Vessel

The sizes of container vessels have significantly increased since Sea-Land introduced the container concept in 1956. Container vessels can be divided into the following categories (Thoresen, 2010):

- **Panamax-size Container Vessels:** These vessels have a width up to 32m and the fourth generation has a capacity of up to 4 500 TEU. A Panamax-size container vessel is the maximum vessel size that can pass through the existing Panama Canal.
- **Post-Panamax-size Container Vessels:** The 6th generation of container vessel has a capacity of up to about 7 000 TEU.
- **Post-Panamax-Plus-size Container Vessels:** The seventh generation of container vessels has a capacity more than 7 000 TEU.
- **ULCV's (Ultra-Large Container Vessels):** These container vessels have an overall capacity of 12 500 TEU or more, maximum length of approximately 380-400m, a beam of 60m and a maximum design draft of between 15m and 21m.

The aim of a maritime container terminal is to accommodate the largest container vessels without it waiting to berth. The larger the vessel, the more the shipping lines can benefit from economies of scale and a reduced cost per TEU slot, of which the Maersk Triple-E is a prime example (refer to Figure 10). The 18 000 TEU Triple-E is currently the largest container vessel in the world. The hull of the Triple-E is U-shaped compared to traditional container vessels, which provides the Triple-E with additional capacity without dramatically increasing the size.



Figure 10: Maersk Triple-E (Maersk Technology)

The following table summarizes the maximum size of container vessels that can enter into some South African ports.

Table 1: Container Vessels – South African Maximum (Transnet Limited, 2011)

Vessel	Dimensions (LOA x Beam x Draft)	Saldanha Bay	Cape Town	Port Elizabeth	Ngqura	East London	Durban	Richards Bay
Panamax	240m x 32m x 12.0m		√	√	√		√	√
Post- Panamax	305m x 40m x 14.0m		√	√	√			√
ULCV	400m x 60m x 15.5m				√			√

The following factors need to be taken into account when determining the design vessel of a maritime port container terminal:

- **Approach Channel Depth:** Depends on a number of factors such as: design vessel draft, maximum sinkage, required net under keel clearance and vessels vertical motion due to wave response.
- **Approach Channel Width:** Depends on a number of factors such as: environmental conditions, type of channel bank and type of cargo that is transported by the vessel.
- **Stopping Length:** Depends on a number of factors such as: vessel entrance speed, time required for tying up tugboats and final stopping distance.
- **Turning Basin:** The size of the turning basin is a function of manoeuvrability and the overall length of the design vessel.
- **Depth Alongside:** Determine the depth criteria, usually relate to the under keel clearance, which ensures the safe entering, berthing and manoeuvring of the ships in the harbour. The following under keel clearance values generally range from 0.3m to 1.0m, depending on whether the seabed material.
- **Basin Width:** The basin width is a function of manoeuvrability and the overall length and beam of the design vessel.

2.8.3 Design Guidelines – CY Equipment

The following section briefly describes CY equipment such as ship-to-shore (STS) gantry cranes and container handling equipment. The description is done due to the fact that one cannot determine the CY area without knowing what type of CY equipment will be used at the maritime or dry port container terminal.

The first specially designed STS gantry crane was completed in 1959. The modern day STS gantry cranes can meet the demand of the Ultra Large Container Vessels, which can stow 32 rows of containers across, and can operate at a capacity of 30-50 moves per hour. Thoresen (2010) stated that although six cranes can be used on a vessel to theoretically improve the serving time, in practice it was found that this is not the case. The author added that this is due to the fact that the cranes can then only operate at a fraction of their capacity and, therefore, the most efficient working system is one that uses four to five cranes per vessel.

Secondly, container handling equipment can be divided into a number of systems, namely: Fork-lift Truck and Reach Stacker system; Straddle-Carrier system; Rubber-Tyre Gantry (RTG)

or Rail-Mounted Gantry (RMG) system; and automated system. The biggest factor in determining which type of system is adequate for the specific application is the stack height. The stack height affects both the total amount of containers that can be stored in the stack and the accessibility to the individual containers within the stack. With limited space available in container terminals the tendency is to stack the containers as high as possible, but this significantly reduces the accessibility of individual containers within the stack. This causes a digging effect by the container handling equipment which leads to a reduction in the container terminal's overall efficiency. Therefore, an optimum balance between these factors must be found. The optimum stacking height for the different systems is (Thoresen, 2010):

- for the fork-lift truck and reach stacker system it is 2 to 3 high;
- for the straddle-carrier system it is 3 high;
- for the RTG or RMG system it is 4 to 6 high.

The RTG system is the current system used by the Cape Town Container Terminal. In this system the STS gantry crane places the container on a terminal tractor or a straddle carrier system, which moves the container to the primary yard area where the RTG system stacks the container. The system usually stacks containers in blocks 5-9 wide and 4-6 high. The average handling capacity of an RTG system can vary from 15 to 25 containers per hour. The RTG system becomes economically viable if the container terminal handles more than 200 000 TEUs per year and is ideal for areas where the CY area is restricted.

The advantages of this system are:

- a high STS gantry crane productivity can be achieved and there is a buffer zone under the STS gantry crane;
- although it has a high capital cost, it has low labour and medium operating cost;
- good stacking density with about 800 TEUs per hectare with stacking of containers four high;
- automation is possible in future development.

The disadvantages of this system are:

- if not implemented correctly the flexibility of the system reduces significantly;
- the system is susceptible to inclement weather conditions (especially wind), which affects productivity and increases downtime.

2.8.4 Design Guidelines – Container Terminal Yard Area

The land requirements are related to the storage density and the time the cargo stays in the maritime or dry port. The container terminal yard area required for the container terminal will be divided into four areas. The four areas are as follows:

- The apron or the area just behind the berth front (only applicable to maritime ports);
- The primary yard area is usually divided into separate stacks for import, export and empty container yard area;
- The secondary yard area, which includes the entrance facility, parking, office buildings and customs facilities;
- The container terminal as a whole, which includes the hinterland capacity, number of berths and required quay length.

2.8.5 Marine Container Terminal Capacity and Utilization

The Tioga Group Inc. (2010) identified that marine container terminal capacity has five long-term constraints or dimensions, as illustrated in the Figure 11 below.

Maritime port and container terminal operators are continually reviewing and adjusting their capacity and their operating practices within that capacity. Container terminals attempt to balance the five dimensions of capacity, viz.

- berths long and deep enough for the biggest expected vessel;
- enough berths and cranes to avoid vessel delay;
- enough container terminal yard area and density to avoid congestion;
- enough hours to serve the vessel.

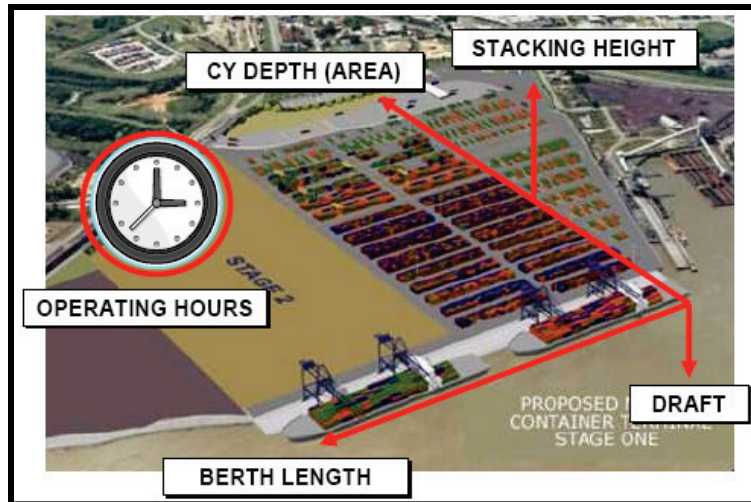


Figure 11: Long-term Constraints (The Tioga Group, Inc., 2010)

In order to determine the productivity of a container terminal it is necessary to understand the definition thereof. According to the Tioga Group Inc. (2010) productivity can most usefully be defined as the combined result of resource utilization and operational efficiency. Resource utilization measures output against capacity and is usually expressed as a percentage. Operational efficiency measures output per unit input and is usually expressed as a ratio. For example, crane moves per hour is an *efficiency* measure, while crane operating hours per day is really a *utilization* measure. Productivity of a given asset may be increased either by increasing utilization or by increasing operating efficiency. Keeping with the crane example, crane productivity could be increased by operating cranes more hours per day (utilization) or by achieving more lifts per operating hour (efficiency).

Due to the complex nature of the maritime port operational system one needs to assess a series of metrics to obtain a full productivity overview of the maritime port and its container terminals. According to the Tioga Group Inc. (2010) the productivity metrics can be divided into three main metrics with each having several sub metrics (refer to sections 2.8.6 to 2.8.8).

These productivity metrics enabled the researcher to determine the utilization of the current infrastructure of the Cape Town Container Terminal, as well as to derive a comparison between the Cape Town Container Terminal and the United States container terminals. The results of the United States container terminals were obtained from the study done by the Tioga Group Inc. (2010).

2.8.6 Land Use and CY Metrics

The following sub metrics are used to assess the land use and CY metrics:

- **TEU Storage Slots (CY Slot Capacity):** the total TEU storage slots in a container terminal reflects the combination of available CY acreage and the CY operating methods in use, as well as characterizes static storage capacity.
- **Annual Throughput (TEU) per Slot (Turns):** the annual throughput (TEU) per slot, or annual slot turns, metric is a productivity measure reflecting the output from the TEU slot “asset”. This metric is at its highest at the busiest ports, indicating a higher utilization of available capacity.
- **Sustainable CY TEU Capacity:** the maximum annual CY TEU capacity of a container terminal, estimated as the product of TEU storage slots and a maximum turnover of 70 per year (equivalent to about one turn every five days), is a benchmark for the maximum TEU that could be handled at the container terminal. The Tioga Group Inc. (2010) noted that the sustainable CY TEU capacity can be estimated at 80% of the maximum, allowing for business peaks and valleys and a margin for growth.
- **CY Capacity Utilization:** the annual throughput (TEU) divided by the sustainable CY TEU capacity (throughput as a percentage of capacity) is a measure of the CY capacity utilization.

2.8.7 Container Crane Metrics

The following sub metrics are used to assess the container crane metrics:

- **Annual Container Crane Capacity:** the amount of containers (TEU) that can annually be handled by the available container cranes.
- **Container Crane Capacity Utilization:** the annual throughput (TEU) divided by the annual container crane capacity (throughput as a percentage of container crane capacity) is a measure of the container crane capacity utilization.

2.8.8 Berth and Vessel Metrics

The following sub metrics are used to assess the berth and vessel metrics:

- **Annual Vessel Calls per Berth:** annual vessel calls per berth is the first factor in berth utilization and productivity. The Tioga Group Inc. (2010) noted that there is some

ambiguity when terminals have a long berth face that can be divided in different ways, as the number of berths can vary from time to time.

- **Vessel Size Ratio (Average Vessel Capacity (TEU) vs. Maximum Vessel Capacity (TEU)):** comparing the average vessel size being handled to the maximum possible vessel size for the available berth depth indicates how much of the inherent berth depth and berth length is being used. This ratio can reach 100% if the port is being served by a fleet of maximum-sized vessels or if tides or light loading are being used to bring in vessels that would otherwise exceed the available berth depth.
- **Berth Call Utilization (Vessel calls per berth vs. maximum calls per berth):** the simplest way to gauge berth capacity utilization is to compare the number of vessels handled (calls) with the maximum that could have been handled. The Tioga Group Inc. (2010) noted that the number of vessels that could have been handled must usually be estimated and is set for this study at 208 per year (80% of a one per weekday maximum of 260).
- **Berth TEU Utilization (Annual TEU per berth vs. maximum TEU per berth for maximum vessel size):** a more complex look at berth utilization takes into account the maximum TEU that could be handled if the maximum size vessel made the maximum number of calls. The Tioga Group Inc. (2010) noted that this is an aggressive comparison since it measures productivity against a standard that is unlikely to be achieved anywhere.

2.9 Maritime Port and Container Terminal Data Sources

To be able to determine the capacity limiting characteristics at the Cape Town Container Terminal one needs to obtain certain maritime port and container terminal data, therefore this section of the study focuses on maritime port and container terminal data sources.

2.9.1 Hurdles to Successful Data Collection

According to the Tioga Group Inc. (2010) the nature of the maritime business and participants create the main hurdles in preventing successful data collection. In most of the world the maritime container terminal operators are private, unregulated businesses that consider cost and productivity data confidential. On the other hand the maritime ports, which are public entities, do not have access to container terminal cost and productivity data. The maritime ports and container terminals have valid objections to comparisons via many of the possible metrics and each maritime port and container only wants to be publicly compared on metrics which

places them in a good light. This competitive environment causes the maritime port and container terminal operators to be very sensitive to the publication of data.

2.9.2 South African Data Sources

The following South African data sources were identified, which enabled the researcher to determine the capacity limiting characteristics at the Cape Town Container Terminal:

- Transnet Port Authority and Transnet Port Terminals in the Port of Cape Town are crucial sources of data in terms of the port as well as the container terminal;
- The CSCMUS is a valuable source of data in terms of the South African as well as the Cape Town market. This institute provides data of growth rates for imports and exports of 75 sectors, which have been identified up until 2018, as well as data related to container numbers in and out of South African ports which have been acquired from various shipping lines operating in the area;
- Published global trade figures from the World Trade Organization, the International Monetary Fund and Transnet.

It should be noted that common definitions and conventions were essential to ensure valid comparisons.

Chapter 3 Containerized Trade

3.1 Introduction

This section of the study briefly describes the effect that containerization has had on the global, African, South African and Western Cape transportation systems. The dry port concept is primarily container orientated and, therefore, the description was made to enable the researcher to fully understand the operational and functional aspects of implementing the dry port concept within the Western Cape supply chain.

3.2 World Containerized Trade

3.2.1 Start of Containerization

Container trade as we know it had its inception on the 26th of April 1956 when Malcolm McLean's converted World War 2 tanker, the "Ideal X", made its maiden voyage from the Port of Newark to the Port of Houston in the USA (Bestenbreur, 2011). By 1966, Sea-Land Services Inc. had commissioned sixteen dockside container cranes, which were capable of transferring containers weighing 27.5 tons at the unheard of rate of 40 handling cycles per hour. This had such a dramatic effect on the cargo trade industry that by 2007, 60% of the world trade was containerized and approximately 90% of non-bulk cargo was transported in containers (Johari, 2007).

3.2.2 Globalization of Trade

International trade takes place among countries in order to gain comparative advantage through the reduction of labour, resources, technology, market location, inventory, and transportation cost. The comparative advantage allows companies that participate in international trade to pursue maximum benefits when comparing locations in which to operate or obtain supplies. This has increased the demand for efficient transportation services.

Strengthening the demand for efficient transportation services is the globalization of trade and economic/trade policies, such as the BRICS (a trade agreement between Brazil, India, China and South Africa) agreement, which has led to the raise and change of transportation requirements as products move through the international supply chain. The BRICS agreement, together with the globalization of trade and the growing global economy, has changed the

Southern African trade patterns by increasing cargo movement between the associated countries and has given South Africa a competitive advantage in the global market. The advantage arising from South Africa's geographical location is illustrated in Figure 12 below, which highlights the central nature of the country in relation to the global trade routes.

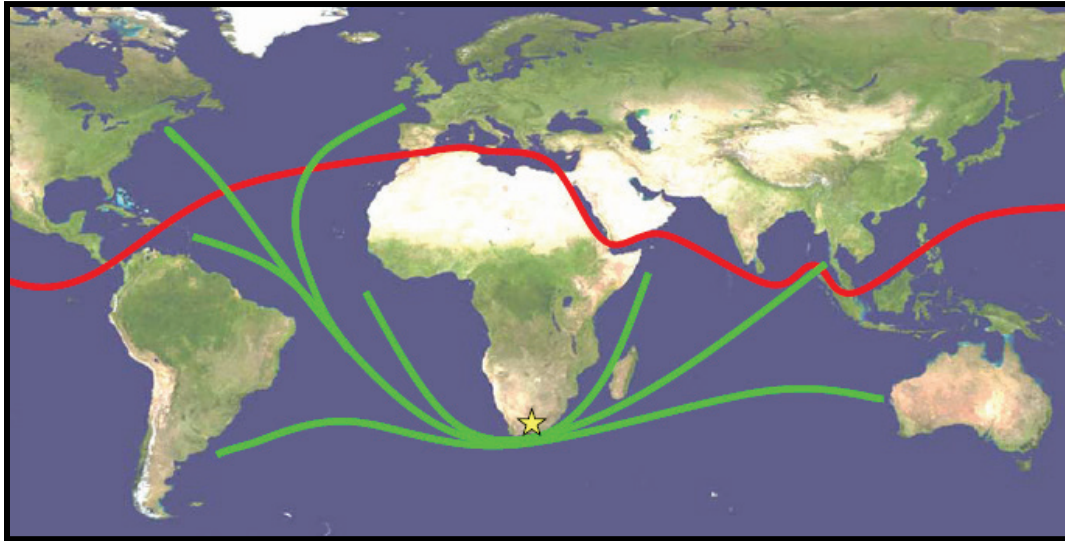


Figure 12: South Africa's Geographical Position

The following trade routes place the Port of Cape Town in the ideal location to attract container cargo volumes (National Department of Transport, 2011):

- Asia-East Coast of South America;
- Asia to West Africa;
- Asia-East Africa;
- India-Brazil-Relay Traffic.

3.2.3 Global and African Container Volumes

In a report published by UNESCAP (2006) the forecasted world container volumes are expected to increase on average by 6.6% year on year, increasing to an estimated 177 million TEU by 2015 compared to an estimated 68.7 million TEU in 2000.

It should be noted that although the abovementioned volumes and growth rates were predicted in 2006, before the world recession in 2009, they are still relevant due to the global dependence on containerized trade. Furthermore, according to Heymann (2011) global container throughput has now recovered. The author determined that the container throughput decreased by nine percent in 2009, but showed that the volumes have increased by 11% in 2010.

Table 2: Forecast Port Container Demand Growth Rate (UNESCAP, 2006)

Region	2006-2012 (growth rate per annum)
North America	6.5%
North Europe	8.8%
South Europe	7.8%
South East Asia	8.3%
Far East	11.4%
Latin America	8.4%
Africa	12.3%
Global	9.8%

The report elaborates on the world container volume forecast by estimating the projected container port demand growth for several regions in the world (refer to Table 2). From the table it is clear that the projected container port demand growth for Africa will be the largest in the world at 12.3%. The high growth rate supports the notion that Africa has the potential to grow as a dominant role player in the world container trade and that it is critical for Africa to be able to handle these growing volumes. This opportunity is increased by the fact that the Port of Durban is the busiest container port in Africa, handling over 2 million TEU per annum in 2006 (Meyer, 2010), as well as the predominant transshipment hub in South Africa. Furthermore, the Port of Cape Town is ranked as the 5th busiest port in Africa handling over 0.6 million TEU per annum in 2006 (Meyer, 2010).

It is also important to note that other African ports are also in the process of upgrading their facilities, which include: Port Louis (Mauritius), Mombasa (Kenya), Lagos (Nigeria), Walvis Bay (Namibia) and Maputo (Mozambique). The increased capacity at these ports creates more competition for the South African ports. As a result South African ports will have to find creative ways of improving the efficiency of the whole supply chain to ensure that they retain their competitive advantage in the African market. Two of South Africa's main competitors include the Port of Walvis Bay and the Port of Maputo.

3.3 South African Containerized Trade

South African containerized trade is strengthened by economic and trade policies such as the BRICS agreement and the trade routes as discussed in section 3.2.2 of this document. These trade policies have opened a gateway for the South African market and have led to a significant growth in containerized trade through the South African maritime ports. South African maritime ports handle approximately 98% of the country's merchandise trade of which containerized

trade forms a significant portion. Furthermore, about 58% of South Africa's GDP or trade is dependent of shipping (SkyMEDIA, 2010, p. 8).

In the overall context of South African trade the export volumes are 2.6 times the import volumes due to the high share of primary commodities in South Africa's export trade market; however in the context of containerized trade the export volumes are equal to the import volumes.

The South African containerized trade market faces the following challenges: firstly, the container vessels deployed on South African shipping routes are small to mid-sized, 5 000 TEU on average, and do not approach the economies of scale of the large container vessels, 11 000TEU, used in the rest of the world. It should, however, be noted that this challenge is being addressed with all of the major ports upgrading their facilities to be able to accommodate these larger ships. Secondly, multiple port calls is a major challenge in the Southern African trade routes because shipping lines are required to make multiple calls at Durban, Port Elizabeth and Cape Town to handle the small parcel sizes. Multiple port calls is a consequence of both the diseconomies of scale referred to above and of the high cost of inland transport. These factors add to cost both through the direct costs of each port call as well as the high risk of schedule disruption from delays in one port having a knock on effect on other ports.

The largest role player in the South African shipping industry is Transnet of which a brief overview is given in section 3.3.1 below.

3.3.1 Transnet

In 1989 the Nationalist Party Government instituted the corporatisation of SATS (South African Transport Services) which required the incorporation of a new private company, Transnet (Pty) Ltd, a holding company in which the unincorporated divisions of ports (Portnet), rail (Transnet), commuter rail (Metro Rail), pipelines (Petronet), airways (South African Airways) and several other enterprises were housed. This wholly state owned enterprise is a private limited liability company with a single shareholder, the Minister of Public Enterprise. In 2001, Transnet's single port division, known as Portnet, was divided into two main businesses, namely Transnet Port Terminals (TPT), the operations side of the business and Transnet National Ports Authority (TNPA), the proprietor business. The responsibilities of these two businesses are as follows:

- TPT is responsible to operate the ports in terms of providing terminal operations;

- TNPA is responsible for controlling the eight South African maritime ports by fulfilling the property owner responsibility for port property and infrastructure, the regulatory function and for the provision of marine services to vessels and marine safety in the form of vessel tracking systems, lighthouses and dredging services (refer to Figure 13).

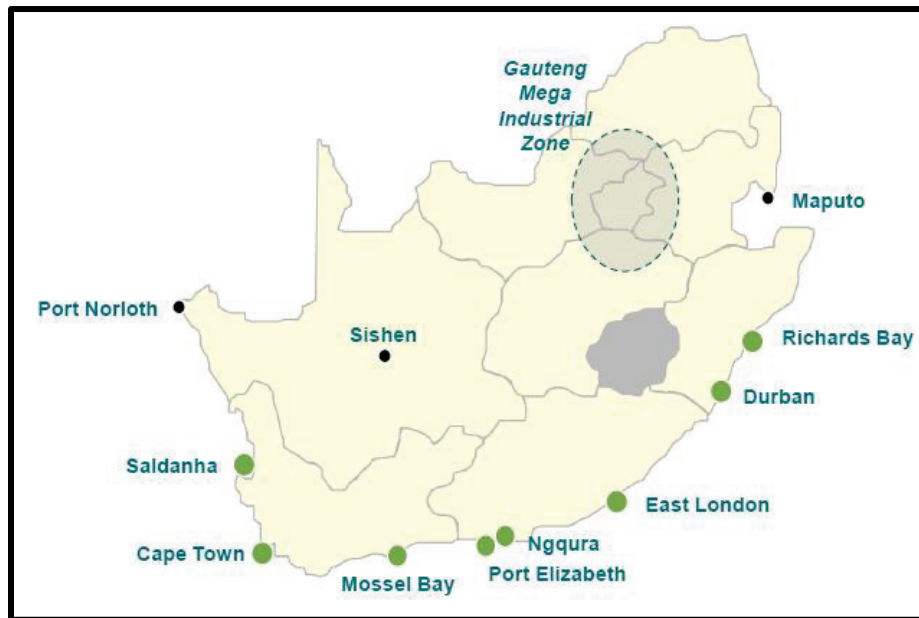


Figure 13: The South African Ports (Pillay, 2011)

3.3.2 South African Container Volumes

The South African container volumes have followed a similar trend than that of global container volumes with a slight decrease in 2009 and 2010 due to the world recession of 2009. The effect of the recession was, however, temporary with the South African container volumes surpassing the 2008 volumes by the end of 2011 (refer to Table 3 and Figure 14).

Table 3: South African Container Volumes (TEU per annum)

Data Source	2008	2009	2010	2011
TNPA (Transnet Limited, 2010)	3 738 000	3 800 000	3 629 000	3 553 000
TNPA (Transnet Limited, 2011)	3 738 000	3 800 000	3 629 000	4 081 000

Despite the world recession, the South African container industry has grown significantly over the last ten (10) years and is expected to continue this trend with a 6% year-on-year-average growth rate (Transnet Limited, 2011) over the next five (5) years (refer to Figure 14).

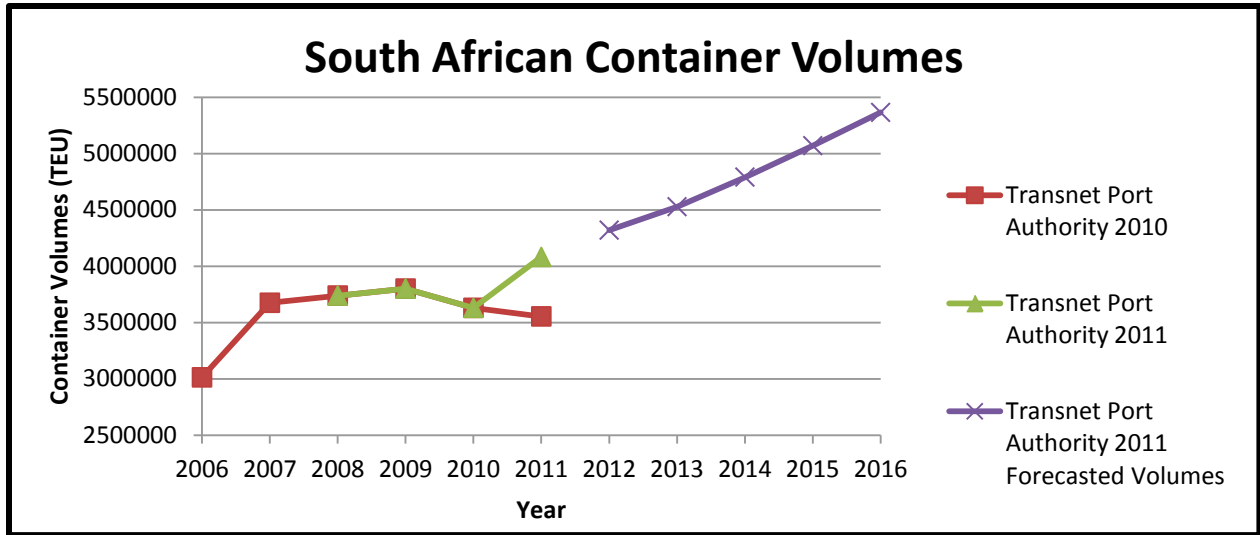


Figure 14: South African Container Volumes

3.3.3 Container volume market share of South African ports

Six (6) of South Africa's eight (8) maritime ports handle containerized cargo, with the Port of Durban leading the way (handling just over 60% of South Africa's containerized trade). The Port of Cape Town is South Africa's second largest container port, with just under 20% of the market share and the Port of Ngqura has steadily increased its market share to over 10% since opening in October 2009. The container volume market share of each of the South African ports is presented in Figure 15.

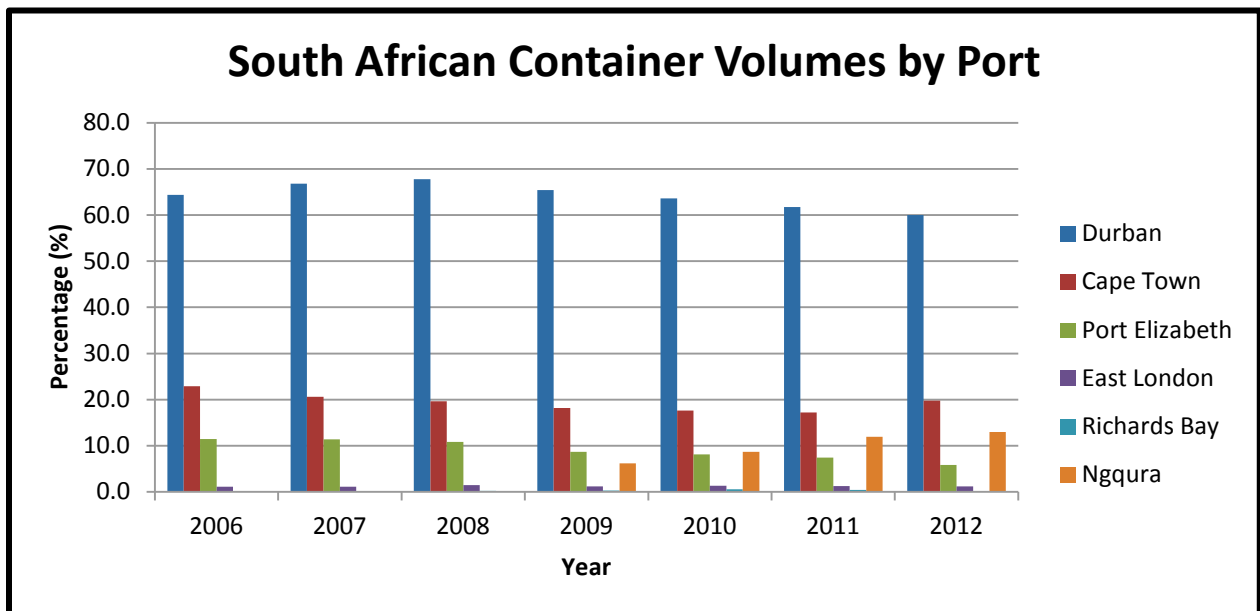


Figure 15: South African Container Volumes by Port (Hutson, 2012)

3.4 The Western Cape

The focus of the section is on the economic profile of the Western Cape and sheds light on the market growth potential within the region, which is critical for the success of the dry port concept.

Over the last five years the Western Cape economy has shifted away from natural resources and commodities toward the services sector. The biggest sectors are the finance, real estate and business services sectors, which contributed 29.17% to the regional economy in 2010 (Wesgro, 2012).

In 2010 the exports and imports totalled R50.4 billion and R104.9 billion respectively (Wesgro, 2012). The top export commodities of the Western Cape are dominated by agricultural products, such as grape wines, citrus fruit (fresh or dried) and grapes (fresh or dried). Furthermore, the Western Cape is responsible for 85% of all South African exports of fish, crustaceans, molluscs, and aquatic invertebrates and 82% of exports of tobacco and manufactured tobacco substitutes (Wesgro, 2012). The top import commodities of the Western Cape are petroleum oils, liqueur/spirits and manufactured goods, such as electrical equipment, plastics, apparel articles, footwear and medical apparatus.

The economic profile of the Western Cape is further examined by focusing on the following trade agreements and policies, initiatives and key markets.

3.4.1 Wesgro's Free Trade Portal

The Western Cape Investment and Trade Promotion Agency (Wesgro) launched a new web-based trade portal in 2012. The complimentary portal enables Western Cape businesses to register their corporate details and post trade leads. The portal allows users to:

- post buying and selling trade leads;
- access a wide range of regional and country briefs, as well as sector research.

3.4.2 The Saldanha Bay Industrial Development Zone (IDZ)

The Western Cape Government initiated the process of creating an IDZ in Saldanha Bay in 2008 to generate economic growth in the region. The purpose of the IDZ is to stimulate national and foreign direct investment and to support the operations of export-oriented manufacturing industries.

3.4.3 The South African Fresh Fruit Industry

The South African fresh fruit industry consists of various varieties of fruit, which include deciduous, citrus and subtropical fruit. Meyer (2010) identified that the primary agricultural industry contributed approximately three percent to the South African GDP and seven percent if secondary production levels are included for the 2009/10 financial year. The South African fruit industry exports fruit in two ways, namely refrigerated (reefer) containers or in bulk. The biggest target markets are Europe and the United Kingdom.

The South African fresh fruits industry mainly transports fruit to the maritime ports by road due to the uncertainty level of our rail network. This causes congestion of the roads, which in turn increases the risk of breaking the cold chain. The consequences of a delay somewhere in the supply chain can be severe as it has a ripple effect throughout the whole supply chain. However, the new corridor strategy of Transnet in conjunction with the “Tonnage off Tar” project has already delivered some results since the implementation in 2008 (refer to section 7.2.3). Currently the rail system is being utilized by the grape, avocado and citrus industries. The corridor strategy drastically reduces the amount of trucks on the roads, because one fruit train eliminates approximately 32 trucks.

3.4.4 The South African Wine Industry

The wine industry is one of the main role players in the Western Cape and has grown significantly after the instatement of democracy in 1994, with exports growing by 335% between 1995 and 2007. Furthermore, it is estimated that the wine industry contributes around R14 billion to the gross domestic product of the Western Cape and South Africa is the 7th largest wine producer (in overall volume) in the world, producing 3.5% of the worlds wine in 2010 (WOSA, 2011).

3.4.5 BMW Rosslyn

In 1973 BMW opened its first foreign plant in Rosslyn, South Africa. The car parts are mostly imported (82% of the parts) from Germany and the United Kingdom, with the assembly function being the primary function of the Rosslyn plant. The bulk of this 82% is imported through the Cape Town Container Terminal and 51% of the imported parts are delivered in a just-in-time manner.

An average of approximately 5 000-6 000 BMW containers are moved through Cape Town Container Terminal per year. This amounts to an estimated revenue earning of R5 million and

to R32 million per annum to Cape Town Container Terminal and Transnet Freight Rail respectively (Olivier, 2012). Although the rail distance between the Port of Durban and Rosslyn is shorter than the rail distance between the Port of Cape Town and Rosslyn, the Port of Cape Town is the preferred maritime port. This is because of the fact that transporting the containers via rail from Cape Town to Rosslyn is nearly 68 hours faster (Olivier, 2012) for southbound vessels that travel from Europe to South Africa along the West coast of Africa. The duration of the two different transportation options is shown in the Figure 16 below.



Figure 16: Comparison of Transportation Durations (Olivier, 2012)

Olivier (2012) noted that road transportation (between the Port of Cape Town and Rosslyn) could further reduce the transportation time; however the increase in cost does not justify the reduction in time.

Chapter 4 Port of Cape Town

4.1 Introduction

This section of the study gives an in-depth description of the Port of Cape Town, which includes the port's strategic position, historical and future container cargo volumes, port infrastructure and the status quo. The aim of this section of the study is to describe the operational and functional aspects of containerized trade within the Port of Cape Town by focussing on the Cape Town Container Terminal.

4.2 History of Port of Cape Town

The first written record of the Port of Cape Town area was made in 1486 by the Portuguese explorer Bartolomeu Dias. In 1652, the Dutch East India Company sent Jan van Riebeeck to set up an away station for Dutch ships. From 1652 up to the early nineteen hundreds, the port had undergone numerous changes, but the basic footprint of the port remained unchanged. The first radical change came in the early 1930s with the start of the foreshore reclamation, which relocated the port out to sea. This reclamation would eventually lead to the port, as it is known today (refer to Figure 17).

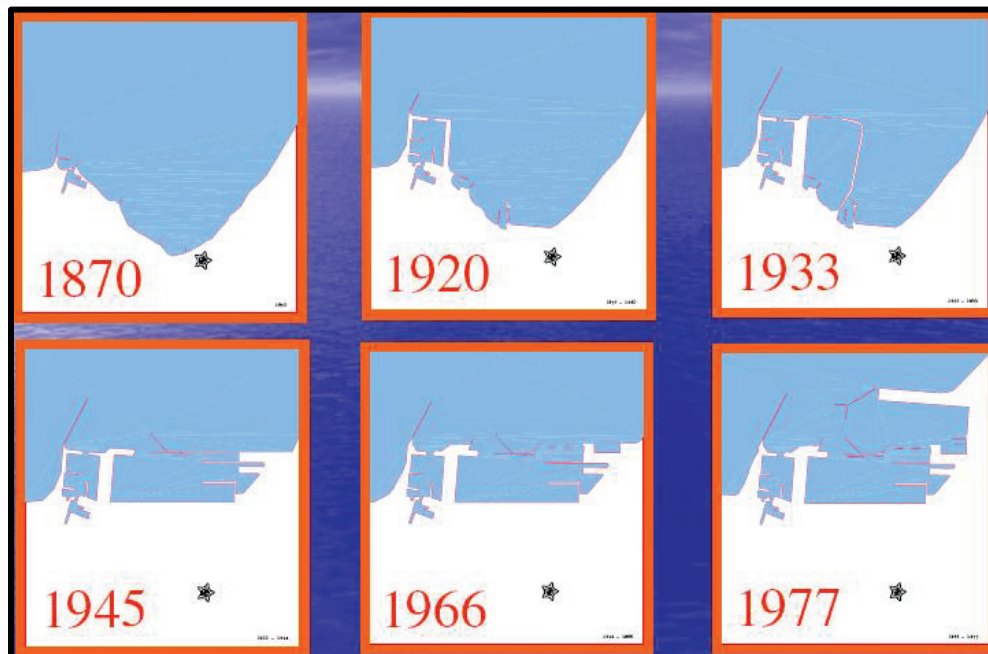


Figure 17: Historic Development of Port of Cape Town (Burgraaf, 2010)

4.3 Strategic Advantage

The Port of Cape Town is the second biggest (in terms of cargo volumes handled) maritime port under the umbrella body of TNPA. The Port of Cape Town is strategically one of the best placed ports in South Africa as it is positioned at the South Western extremity of the continent of Africa, thereby linking America and Europe with Asia, the Far East and Australia. Further to this, the Port of Cape Town also forms a direct link between international trade and about three (3) million consumers in the Western Cape. Through the direct link, the Port of Cape Town facilitates most of the trade in the Western Cape. It is an important medium for both goods destined for overseas markets as well as those coming in to boost the region's economy. The port's financial performance thus mirrors the regional economic climate, with all operational efficiency gains and losses spiralling out into the entire regional economy. The Port of Cape Town has an annual turnover of R1.141 billion, an asset portfolio worth in the region of R7.818 billion, employs 771 people and contributes a significant portion to the region's GDP (SkyMEDIA, 2010). The port anchors key sectors of the Western Cape region namely: fishing, agriculture (fresh produce exports), oil and gas, and also includes retail consumer goods.

4.4 Container Cargo Volumes

In order to assess the Port of Cape Town's strategic position one needs to evaluate the following two critical components, namely cargo volumes previously handled, as well as projected future cargo volumes.

4.4.1 Historical Container Cargo Volumes

The Port of Cape Town container cargo volumes have followed a similar trend to that of the South African containerized trade market with a reduction in volumes in 2010; however, by 2011 the volumes had recovered. In 2012, the container cargo volumes showed the first significant growth rate in over five (5) years and has seen the container volumes reaching a record high of over 850 000 TEUs per annum (refer to Figure 18).

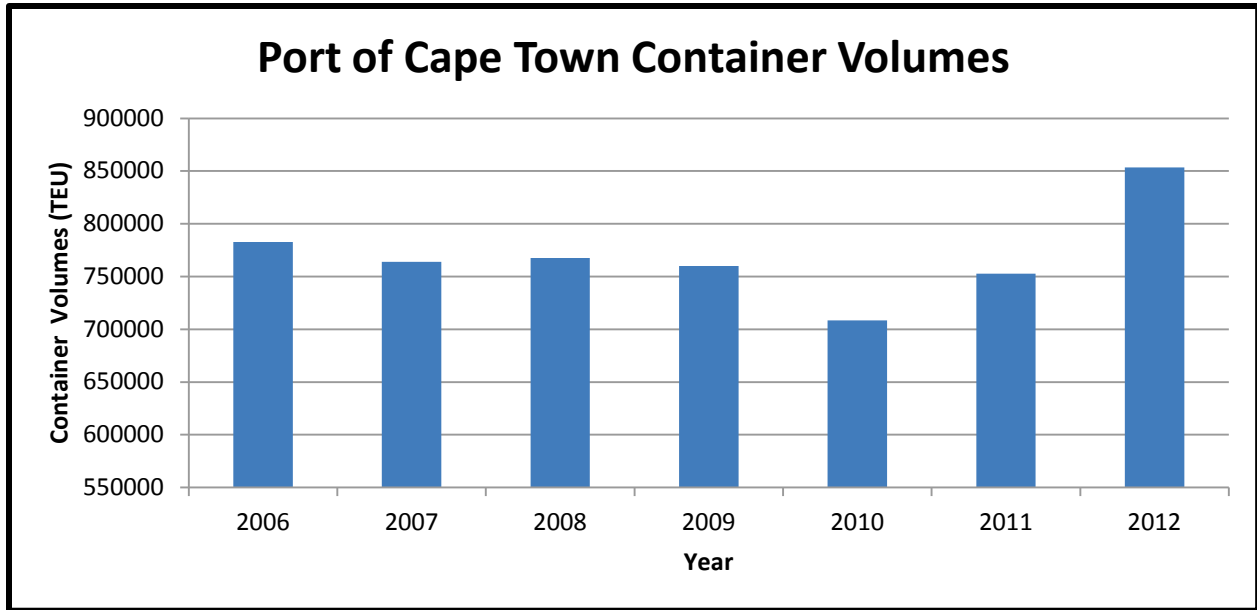


Figure 18: Port of Cape Town Container Volumes (Ruthenavelu, 2012)

The Port of Cape Town container volumes have no specific seasonal peak; however, a slight increase in container volumes is experienced in the summer months (refer to the black circles in Figure 19) due to the increased amount of fruit exports during this period. The monthly container volumes of the Port of Cape Town are presented in Figure 19.

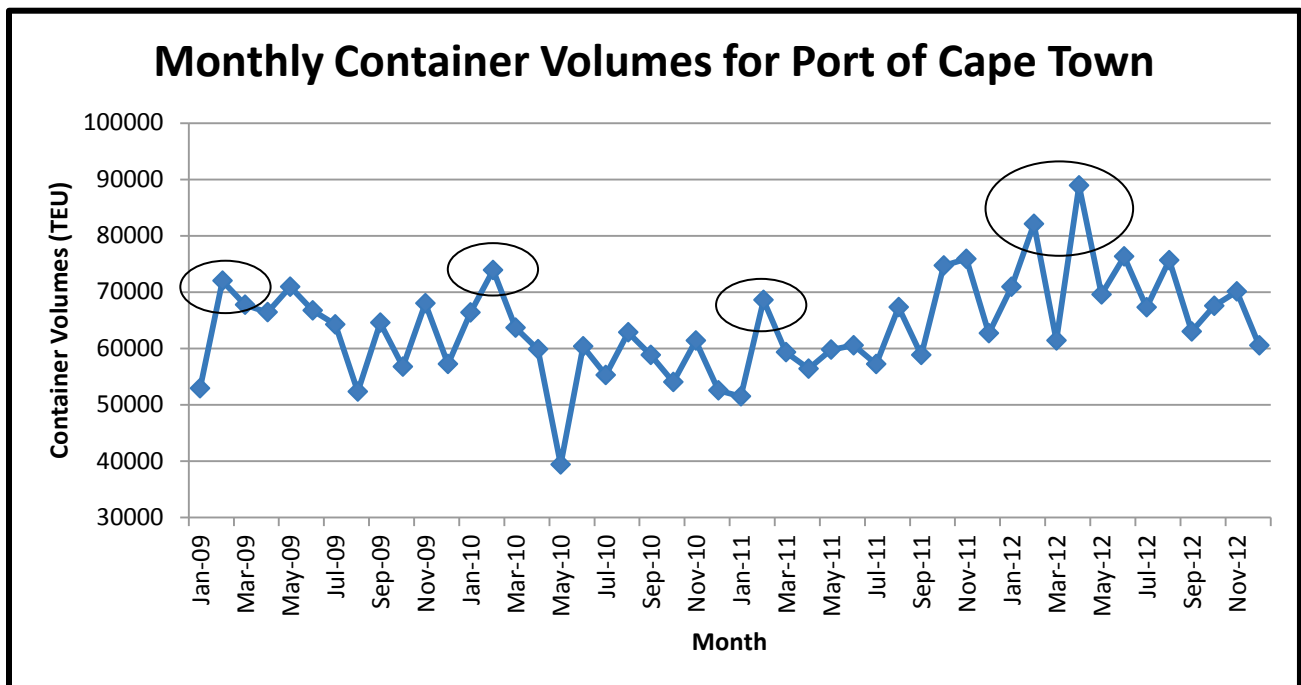


Figure 19: Monthly Container Volumes for Port of Cape Town (Hutson, 2012)

The above mentioned container cargo volumes consist of imported container and exported containers. These containers have on average a 50% share between import and export, and therefore the total volumes consist of 50% imported containers and 50% of exported containers (Ruthenavelu, 2012).

The imported containers that are handled at the Port of Cape Town can be divided into the following general categories (refer to Figure 20):

- **Coastwise:** containers that are shipped to the Port of Cape Town from location along the Eastern and Western Coast of Africa. On average the Coastwise containers account for around 6% of the imported container cargo volumes;
- **Deep-sea:** containers that are shipped to the Port of Cape Town from locations other than the Eastern and Western Coast of Africa. On average the Deep-sea containers account for around 77% of the imported container cargo volumes;
- **Transhipped:** containers that are handled at the Port of Cape Town, but are destined for a different location. On average the Transhipped containers account for around 17% of the imported container cargo volumes.

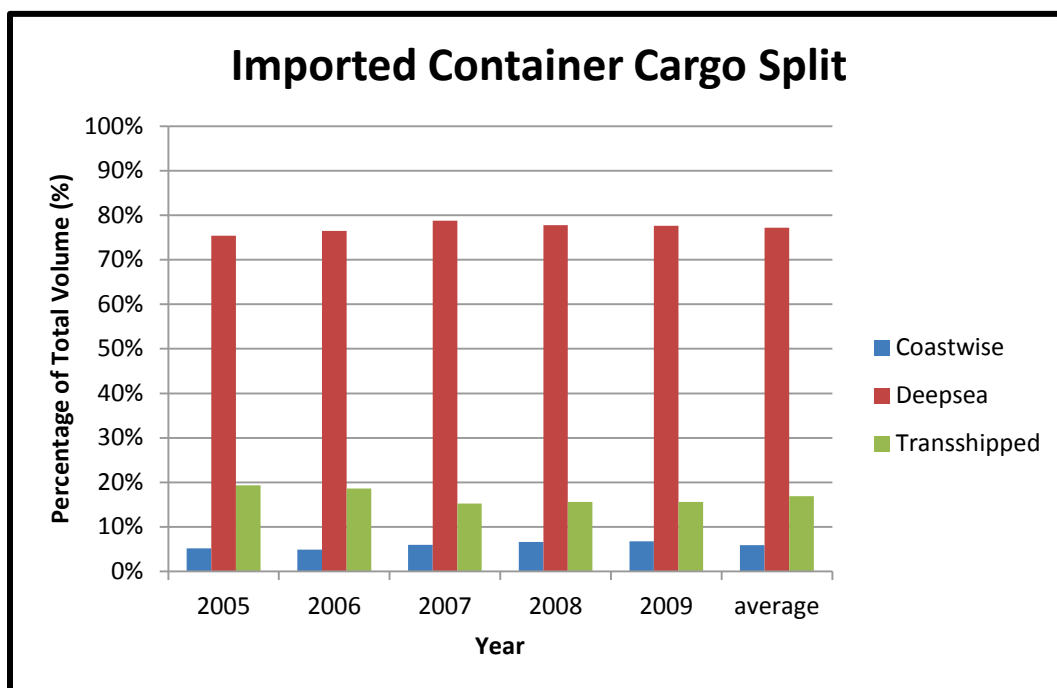


Figure 20: Imported Container Cargo Split (Department of Roads and Transport - Limpopo, 2012)

The exported containers that are handled at the Port of Cape Town can be divided into the following general categories (refer to Figure 21):

- **Coastwise:** containers that are shipped from the Port of Cape Town to location along the Eastern and Western Coast of Africa. On average the Coastwise containers account for around 3% of the exported container cargo volumes;
- **Deep-sea:** containers that are shipped from the Port of Cape Town to locations other than the Eastern and Western Coast of Africa. On average the Deep-sea containers account for around 81% of the exported container cargo volumes;
- **Transhipped:** containers that are handled at the Port of Cape Town, but are destined for a different location. On average the Transhipped containers account for around 16% of the exported container cargo volumes.

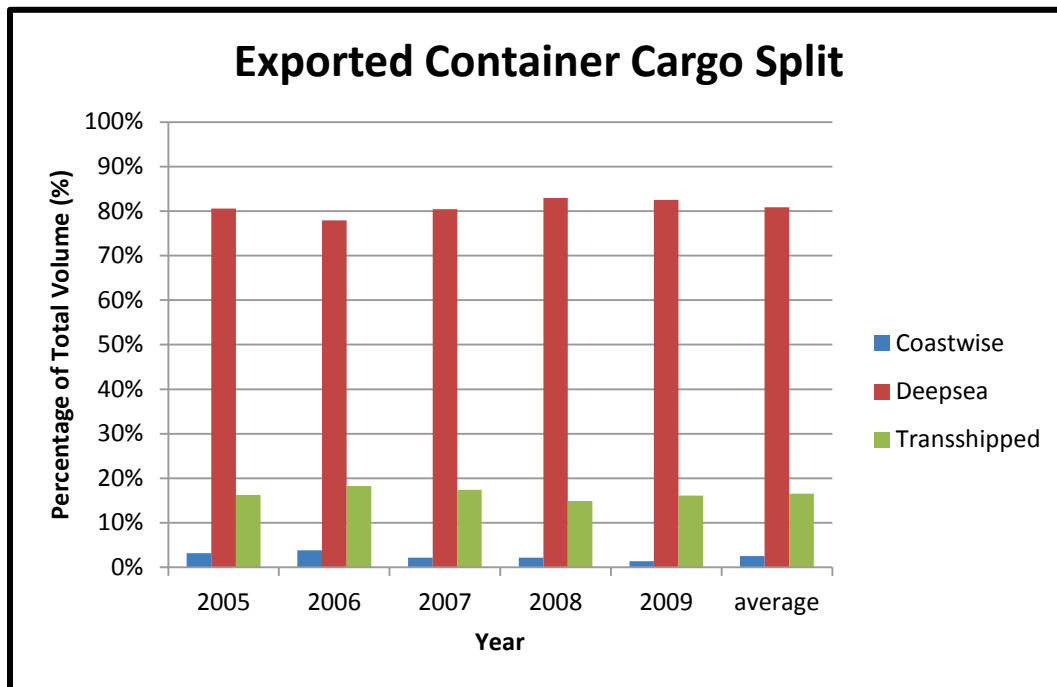


Figure 21: Exported Container Cargo Split (Department of Roads and Transport - Limpopo, 2012)

The Port of Cape Town also handles empty containers which accounts for around 40% of all imported containers and around 20% of all exported containers (Ruthenavelu, 2012).

4.4.2 Forecasted Container Cargo Volumes

Forecasting container cargo volumes is one of the most complex areas in the logistic field, due to the fact that these volumes are significantly influenced by a wide variety of factors. The

complexity of forecasting container cargo volumes results in the availability of several forecasts, each calculated in different ways with its own assumptions; therefore, one should be mindful of selecting and comparing any forecasts that have been done. The following four (4) forecasts were used for the purposes of this study:

- a forecast by Transnet (refer to Appendix B);
- a forecast by the CSCMUS in 2009 (refer to Appendix B);
- a forecast by Meyer (2010) in conjunction with the CSCMUS, refer to Appendix B;
- a forecast during this study, based on the monthly container volumes that pass through the Port of Cape Town (refer to Appendix B).

The results of these forecasts were compared and are shown Figure 22 below.

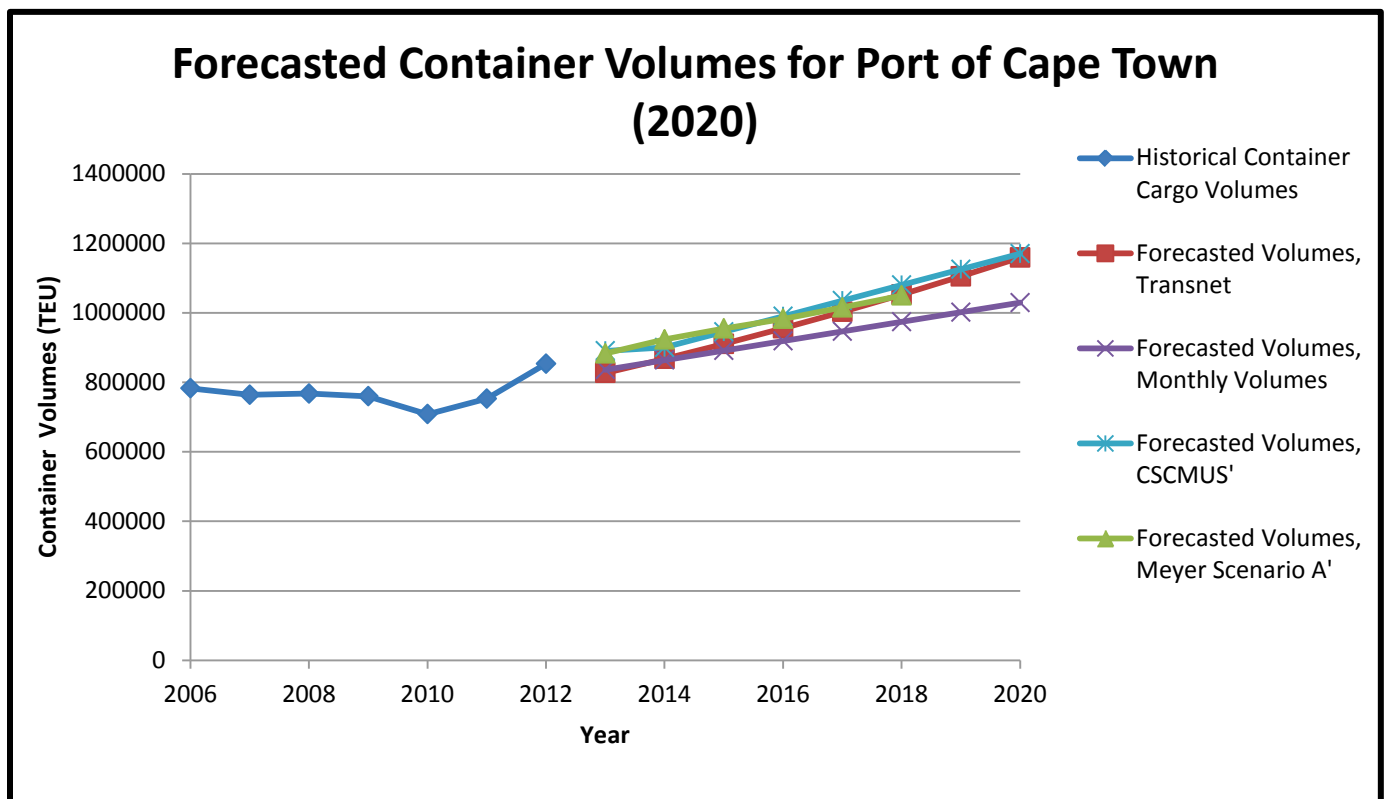


Figure 22: Forecasted Container Volumes for port of Cape Town

From Figure 22 it is clear that the volumes in the Port of Cape Town are expected to grow with between 3% and 5% (year on year average) from 2013 to 2020. The Transnet, CSCMUS' and Meyer Scenario A' forecasts followed a very similar trend and predict that the container volumes in the Port of Cape Town should reach around 1.2 million TEU in 2020.

The forecasts were then used to predict a band of possible future container volumes, with an upper limit of 5% growth and a lower limit of 3% growth (year on year average). Figure 23 shows the predicted future container volumes for 2039 and compares it with a forecast that was done by the CSCMUS in 2009. The predicted future container volumes show that the demand in the Port of Cape Town could reach between 1.9 million and 3.2 million TEU per annum by 2039.

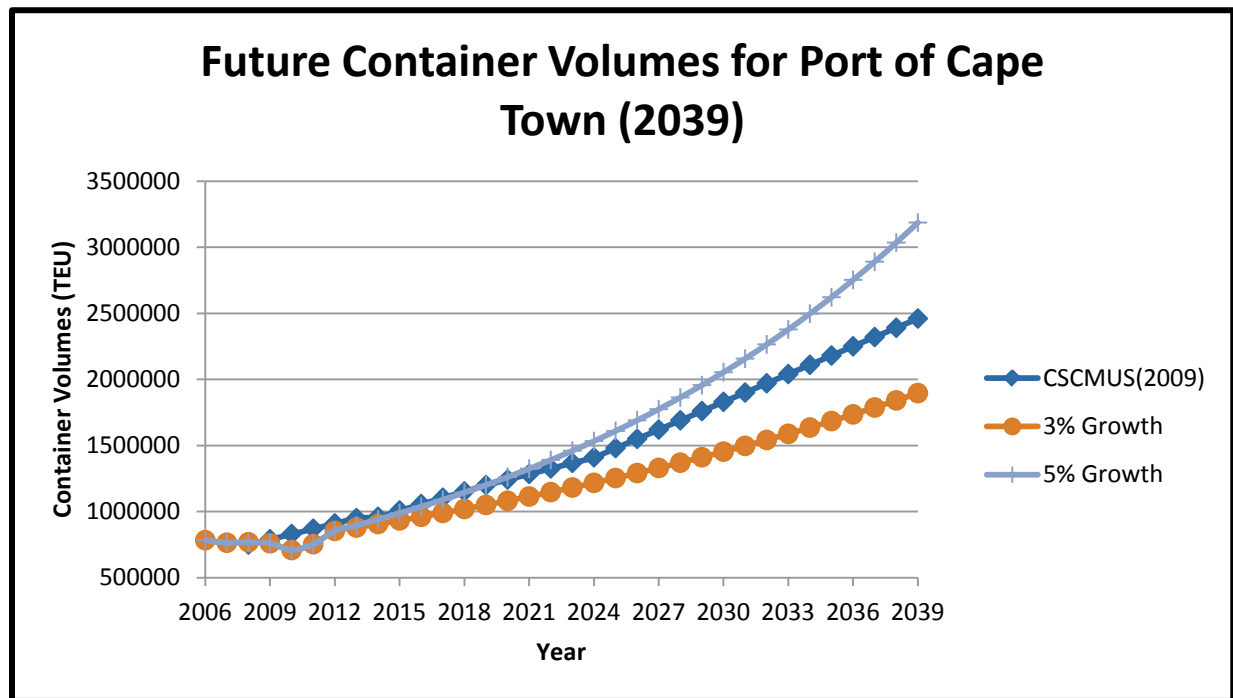


Figure 23: Future Container Volumes for the Port of Cape Town

The detailed description of how each of these four (4) forecasts were obtained and adjusted so that it could be used in this study is presented in Appendix B.

4.4.3 Cape Town Container Terminal Cargo Volumes

The Port of Cape Town handles containerized cargo in three different areas throughout the port, namely the Cape Town Container Terminal, the Fresh Produce Terminal and the Multi-Purpose Terminal. The average cargo split between these terminals is presented in Figure 24 below.

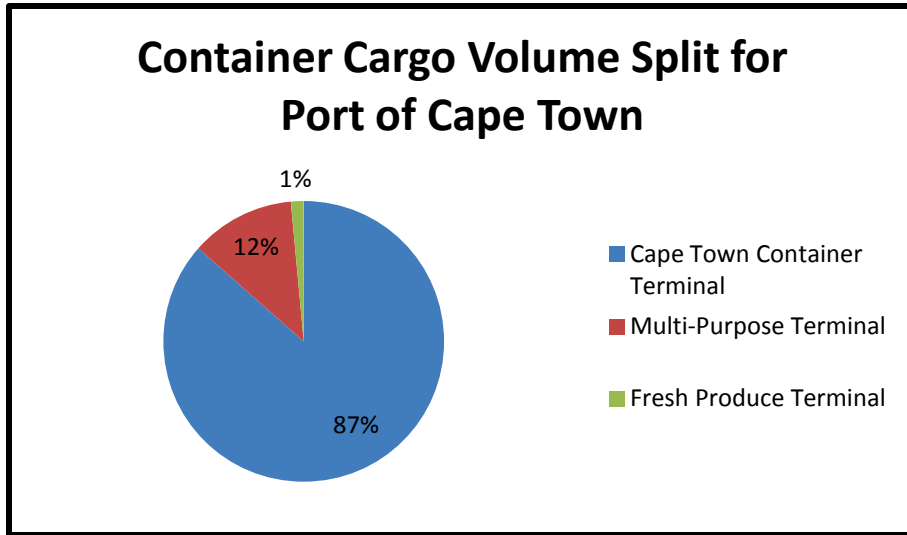


Figure 24: Container Cargo Volume Split for the Port of Cape Town (Ruthenavelu, 2012)

For the purpose of this study these values were used to determine the historical and forecasted container volumes for the Cape Town Container Terminal (refer to Figure 25 below).

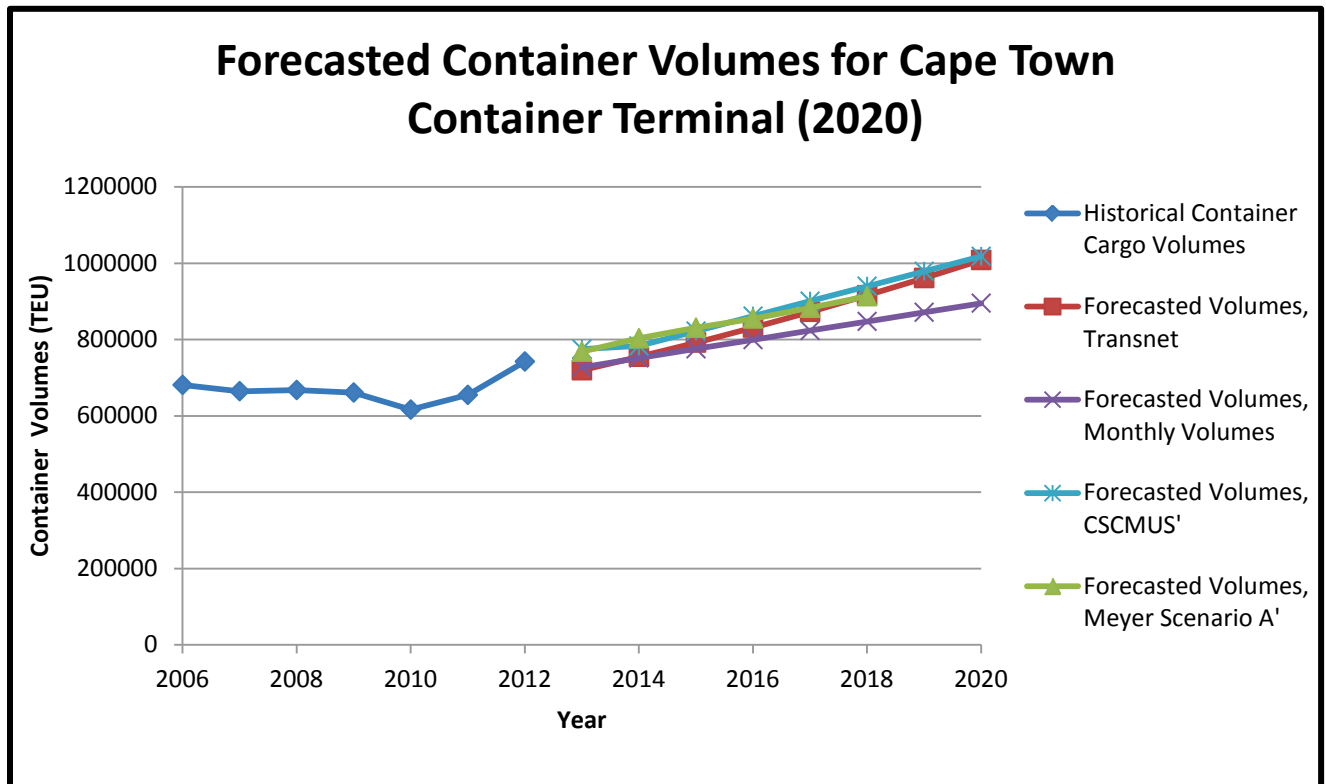


Figure 25: Forecasted Container Volumes for the Cape Town Container Terminal

From Figure 25 it is clear that the volumes in the Cape Town Container Terminal should reach 1.0 million TEU per annum in 2020.

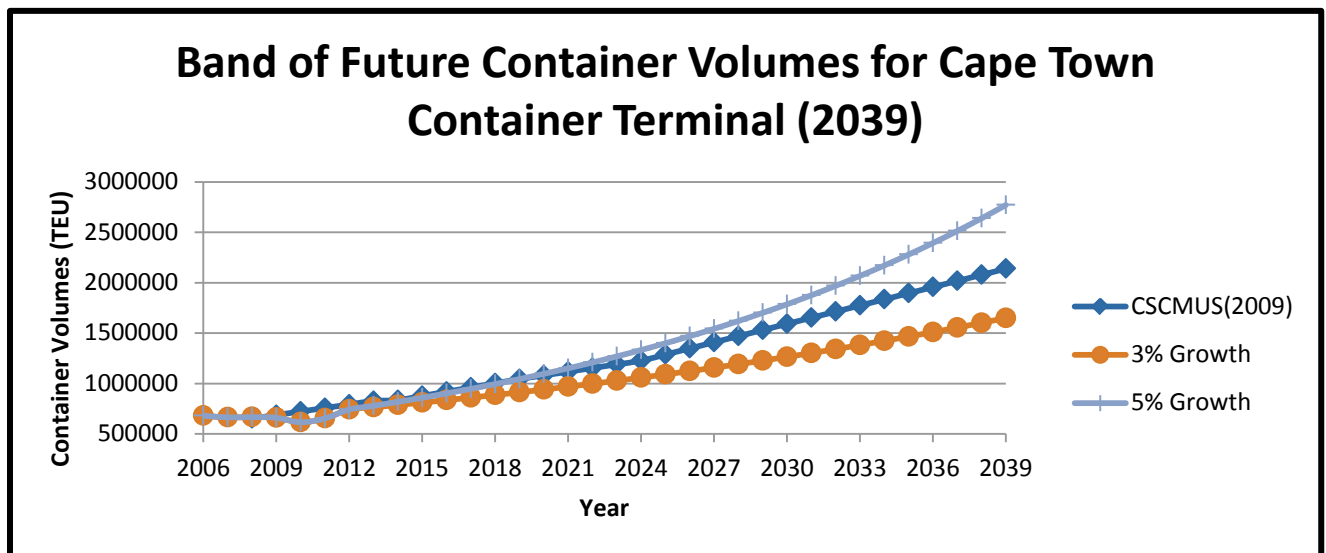


Figure 26: Band of Future Container Volumes for the Cape Town Container Terminal

The predicted future container volumes show that the demand in the Cape Town Container Terminal could reach between 1.6 million and 2.7 million TEUs per annum by 2039 (refer to Figure 26).

It should be noted that these volumes are only relevant if the container operations in the port remain the same as the current operations. If the Fresh Produce Terminal and the Multi-Purpose Terminal are no longer being used for container operations, then the demand for the Cape Town Container Terminal will be the same as that of the Port of Cape Town.

4.5 Port Facilities

The Port of Cape Town is the second largest South African maritime port (in terms of cargo volumes handled) under the umbrella body of TNPA and the port is a full-service general cargo and container port that operates 24-hours a day. The modern Port of Cape Town contains four main docks: the Victoria Basin, the Alfred Basin (used for recreation and fishing), the outer Ben Schoeman Dock and the older inner Duncan Dock. The Ben Schoeman Dock is the home of the Cape Town Container Terminal (refer to Figure 27 and section 4.6), and the Duncan Dock contains the fruit and multi-purpose terminals, the dry dock, repair quay, and tanker basin. The original Port of Cape Town, the Victoria and Alfred Basins, are not only home to the city's waterfront, but also serve fishing and pleasure boats, smaller commercial boats, and smaller

passenger cruise ships. In total, the Port of Cape Town contains 34 berths and large ship repair facilities. Waterside access is gained via a North-South 450m (Panargo Shipping (PTY) LTD, 2006) wide approach channel. The entrance to the Port of Cape Town basins is 180 meters wide and the entrance depths of the Duncan Dock and Ben Schoeman Dock are -14.6m CD (below chart datum) and -15.5m CD respectively (Ruthenavelu, 2012).

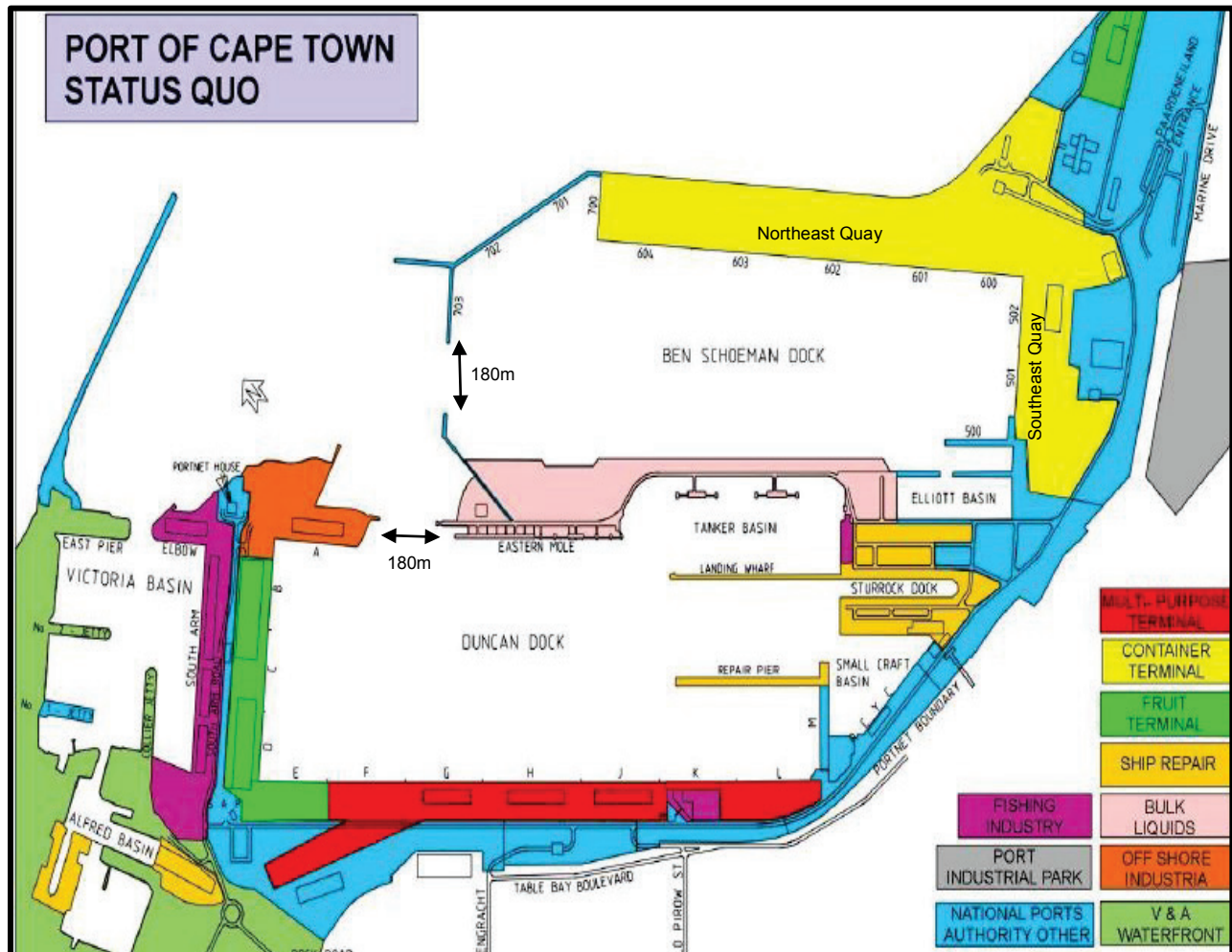


Figure 27: Berth Layout – Port of Cape Town (Ruthenavelu, 2011)

The Ben Schoeman Dock is a 1 830m x 500m x -15.5mCD basin that consists of two major parts, namely (refer to Figure 27):

- **The Southeast Quay:** consists of three berths with a total berthing face of 567m, which is dredged to a level of -10.7m CD (refer to Table 4).
- **The Northeast Quay:** consists of nine berths with a total berthing face of 2225m, which is dredged to various depths along the quay (refer to Table 4).

Table 4: Berths at Ben Schoeman Dock

Quay	Berth	Berth Length	Dredge Level
Southeast Quay	500	201m	-10.7m CD
	501 & 502	366m	
Northeast Quay	600	220m	-10.7m CD
	601 to 604	1140m	-15.5m CD
	700 to 703	865m	-10.0m CD

Note that the numbers of the berths are stated in small black text in Figure 27.

4.6 The Cape Town Container Terminal Expansion Project

The Container Terminal Expansion projects' planning phase started in 2007 and during this planning phase, several expansion options were considered (Ruthenavelu, 2011), namely:

- A. reclamation option within port (Quay 501/502);
- B. stack capacity in Port Industrial Park Site;
- C. reclamation option within port (Duncan Dock);
- D. seaward reclamation.

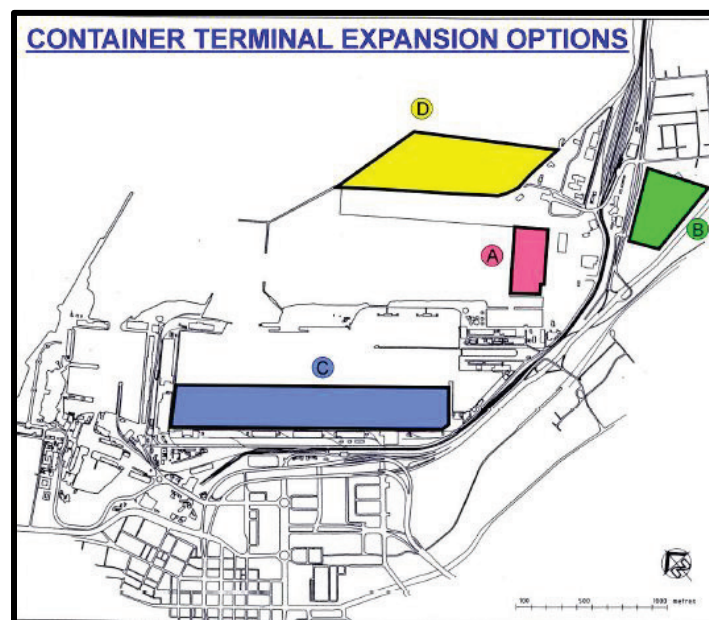


Figure 28: Expansion Options (Ruthenavelu, 2011)

The planning phase determined that options A, B and C were not viable and concluded that the seaward reclamation option (D) was the best option in terms of operational efficiency. This option entailed the reclamation of an area 300 meters wide parallel to and seawards of the existing container terminal to increase the size by about 47.5 ha. This option was, however, not implemented because of the expected negative environmental impact. Several studies, conducted by the CSIR, concluded that this expansion could possibly have negative consequences on the wave climate and the coastal processes, mainly affecting the Atlantic north-coast, especially the regions of Milnerton, Table View and Bloubergstrand (CSIR, 2004).

Therefore, none of the above mentioned options were pursued and the following phased development approach was implemented:

Table 5: Phased Development (Ruthenavelu, 2011)

Description	Capacity	Implementation Duration
Phase 1	700 000 TEU to 800 000TEU	2008 to 2011
Phase 2	800 000 TEU to 1 400 000 TEU	2008 to 2013

In January 2008 the Port of Cape Town started the Container Terminal expansion project which will amount to an investment of R5.6 billion and increase the port's container capacity from around 0.7 million TEU to 1.4 million TEU per annum by 2013 (SkyMEDIA, 2010). The different phases of the expansion project are described in the sections 4.6.1 and 4.6.2.

4.6.1 Phase 1 Expansion

The characteristics of the Cape Town Container Terminal after the Phase 1 expansion were as follows (Ruthenavelu, 2011):

- The CY area consisted of 16 158 total slots, which consisted of 4 858 ground slots and 1 584 reefer plug points (Ruthenavelu, 2011);
- The container terminal quays were furnished with six STS gantry cranes (15 years old) and a reach of 16 TEU wide;
- The stacking method used in the CY was a Straddle Carrier System with haulers and trailers conveying the containers from the STS gantry cranes to the primary yard. The Straddle Carrier System consisted of 30 straddle carriers with 1 over 3 stacking capacity.

The characteristics listed above had a couple of fundamental capacity constraints, which included insufficient CY area, STS gantry cranes that needed to be replaced and the CY equipment could not cope with current and projected volumes. These constraints restricted the maximum operating capacity of the Cape Town Container Terminal to around 0.8 million TEU per annum (Ruthenavelu, 2011), which in turn led to the Cape Town Container Terminal expansion project (phase 2) which was started in 2008.

4.6.2 Phase 2 Expansion

The characteristics of the Cape Town Container Terminal, after the completion of the Phase 2 expansion, were as follows (Ruthenavelu, 2011):

- The CY area has increased by increasing stacking density and the demolition of non-essential infrastructure. The CY area has increased from 16 158 total slots to 32 762 total slots, which consist of 5 766 ground slots and 3 932 reefer plug points;
- The container terminal quays have been refurbished with six (6) new Super Post Panamax STS gantry cranes and these gantry cranes have a reach of 23 TEU wide. Note that although eight (8) cranes were ordered for the Cape Town Container Terminal only six (6) were commissioned. The remaining two (2) cranes were reassigned to be commissioned at the Port of Ngqura;
- The stacking method has changed from a Straddle Carrier System to a Rubber Tyre Gantry (RTG) System. The RTG System consists of 32 RTGs with stacking capacity of 6wide x 5high x 30deep (refer to section 2.8.3);
- The refurbishment of the quay wall (deck on piles), which allowed the increase of the depth alongside at the container berths (Berths 601 to 604). The depth alongside increased from between 9m and 13.9m to 15.5m below CD.

Together with the infrastructure upgrade the expansion project also entailed several efficiency improvements, which included:

- The construction of a Truck Staging Area;
- The construction of the Port Industrial Park access bridge;
- The upgrading of Communication and Instrumentation technology (including Gate Automation);
- The standardization of the Operational System, Navis SPARCS (Synchronous Planning and Real Time Control System);

- The modification and upgrading of the Terminal Entrance;
- An aggressive recruitment and training program for operators of lifting equipment.

According to Ruthenavelu (2011) the characteristics listed above enable the Cape Town Container Terminal to have a maximum operating capacity of around 1.4 million TEU per annum at the completion of the project in 2013.

4.6.3 Limits of the Expansion Project

The recent expansion of the Cape Town Container Terminal significantly improved the CY capacity; however, according to the predicted container volumes for the Cape Town Container Terminal (refer to Figure 29) the limit of the Phase 2 expansion will already be reached in 2025 (5% growth rate) or 2034 (3% growth rate).

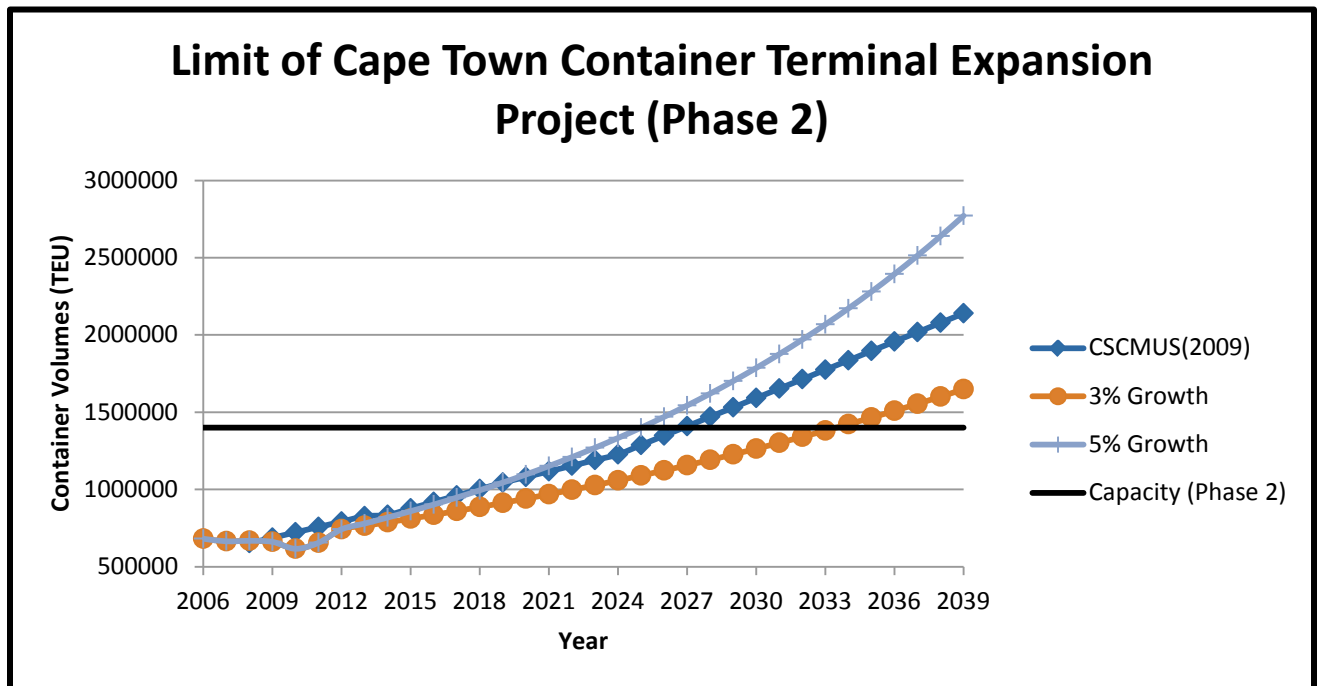


Figure 29: Limit of Cape Town Container Terminal Expansion Project (Phase 2)

The predicted future container cargo volumes will result in a lack of storage space at the Cape Town Container Terminal, which will have the following main consequences (refer to Table 6):

Table 6: Main Consequences (CSIR, 2004)

Additional Cost	Type of Cost	Affected Party
Ships queuing for berths	Additional operating cost	Ship operators
Long ship turnaround time	Additional operating cost	Ship operators
CY congestion	Additional equipment, stack capacity and labour required	Terminal operators
Port traffic congestion	Additional transport required	Transport operators and other traffic users
Longer dwell-time of cargo	Higher inventory costs	Cargo owners and end users
Higher inventories	Late arrival on markets and wastage	Cargo owners and freight forwarders

These consequences ultimately lead to the inability of the port to handle the market demand of the region.

4.7 Hinterland Connections

The Port of Cape Town is currently served by both road and rail networks. The road network is the dominant carrier of goods mainly due to the predominance of the containerized and break-bulk products handled by the maritime port.

4.7.1 Road Network

The road network serving the Port of Cape Town can be divided into two distinct parts (refer to Figure 30). Firstly, the main internal road network, which does not contain any public traffic:

- **Duncan Road:** this 2-lane single carriageway forms the spine road within the port.
- **Container Road:** this 4-lane dual carriageway links the Ben Schoeman Dock with Marine Drive and Duncan Road.
- **South Arm Road:** this 2-lane road provides access to South Arm, V&A Waterfront and the North side of the Duncan Dock.

Secondly, the external road network, which services the maritime port directly but contains a combination of maritime port and public traffic:

- **N1 Table bay Boulevard:** this major 6-lane dual carriageway freeway mainly runs on the perimeter of the port linking the four entrance points, as well as links the port to the rest of the metropolitan area and hinterland. It operates at maximum capacity during peak hours.
- **Marine Drive:** this major 4-lane dual carriageway arterial mainly serves the Duncan Dock, Ben Schoeman Dock and the Container Depot, as well as links the port to the Milnerton and Montague Gardens areas. It operates at maximum capacity during peak hours.
- **N2 Nelson Mandela Boulevard:** this major 4-lane dual carriageway arterial forms part of the N2 network and links the Cape Town central business district with the Southern Suburbs. It operates at maximum capacity during peak hours.
- **Dock Road:** this 2-lane single carriageway serves the V&A Waterfront and Duncan Dock.
- **Heerengracht Street and Christiaan Barnard (previously known as Oswald Pirow) Street:** these 2-lane single carriageways provide access to maritime port via Duncan Road.

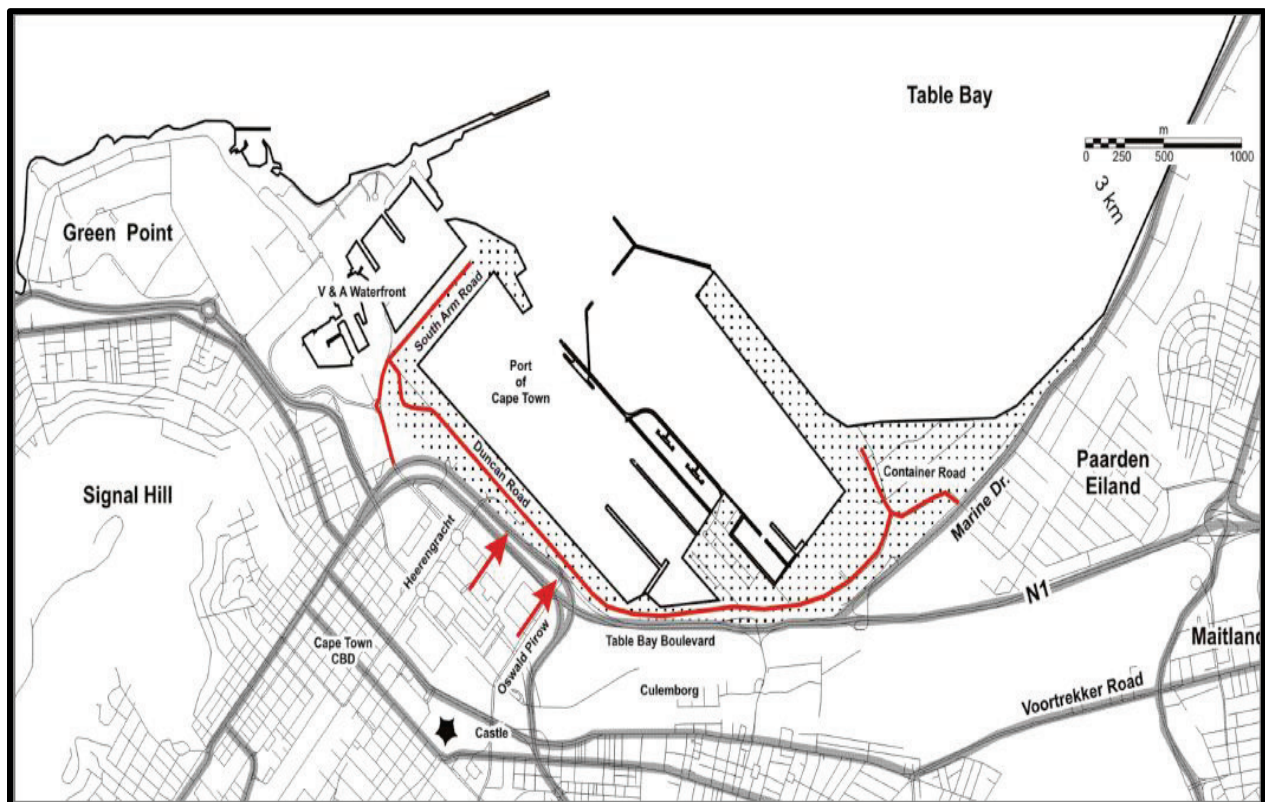


Figure 30: Road Network (CSIR, 2004)

4.7.2 Rail Network

The rail network serving the Port of Cape Town comprises two parts. Firstly, the internal rail network:

- The internal rail network runs along Dock Road at the back of the landside operational areas;
- The Ben Schoeman marshalling yard is the only significant yard within the maritime port boundary and is grossly under-utilized;
- Due to the under-utilization of rail infrastructure and to reduce maintenance costs, all overhead track equipment (rail electrification) has been removed.

Secondly, the external rail network, which services the maritime port from two main directions:

- **Rail Access No.1:** this rail line serves the maritime port from the North (Milnerton) via Bull Nose, along the Atlantic Ocean.
- **Rail Access No.2:** this rail line serves the maritime port from the East via Bay Junction.

4.8 Inefficiencies in the Cape Town Container Terminal

Olivier (2012) and Richer (2010) identified the following inefficiencies in the supply chain of the Cape Town Container Terminal:

- information integrity and customer discipline;
- access to the hinterland;
- vessel congestion at port;
- the lack of cargo being transported by rail;
- road congestion;
- low productivity.

4.8.1 Information Integrity and Customer Discipline

Two of the main inefficiencies that were identified are customer discipline and information integrity. Both of these inefficiencies create major challenges in the supply chain as all parties rely heavily on information supplied by the predecessors in the chain. One of the main causes of these inefficiencies is the fact that in a lot of instances information is still transferred manually. This necessitates the recapturing of information, which takes time and causes delays within the supply chain. Document preparation and customs clearance contributes to more than 50% of the total cycle time in both the cases of importing and exporting a container (Olivier, 2012).

TPT has started to address these inefficiencies by implementing a national terminal operating system, Navis SPARCS. The Navis SPARCS system integrates all South African maritime port and rail operations and allows the maritime container terminals and shipping lines to transfer information. However, for this system to be successful and reach its full potential it needs to be implemented and enforced throughout the supply chain.

4.8.2 Access to the Hinterland

South Africa's maritime ports lack multiple access points, which contribute to the inefficiencies in the industry. Most of the maritime ports are situated in metropolitan areas where the traffic density is already high without the container trucks adding to this congestion. In the report, 6th annual state of logistics in South Africa (CSIR, 2009), it is shown that transportation contributes 50% to the total logistics costs of South Africa and that congestion contributes approximately 2% to South Africa's transportation cost (this amounts to nearly R1.0 billion).

These inefficiencies could be addressed by streamlining the intermodal transport system with that of the maritime port by utilizing the periods during the day when traffic on the roads is less dense. The implementation of an appointment system would allow the alignment of the operating hours of importers, exporters and transporters to that of the terminals. The maritime container terminal can then spread the appointments across a 24-hour period and therefore manage maritime port congestion (Olivier, 2012).

4.8.3 Vessel Congestion at Ports

The world-wide increase in container cargo volumes has increased the number of vessel calls at the South African maritime ports. This increase in vessel numbers is causing congestion, which increases the possibility of delays in the system and creates serious commercial and financial problems for shipping lines. The following factors leads to vessel congestion and delays:

- inclement weather conditions (refer to section 4.9 of this study);
- the bunching of vessels;
- inefficient road or rail transport systems;
- inefficient cargo handling at maritime container terminals;
- customs clearance problems.

4.8.4 Lack of Cargo Transported by Rail

The following extract from a report produced by the National Department of Transport (2011: Part 2) gives a clear insight into the reason for the current dominance of road freight in the supply chain:

“Transport Deregulation Act, 1988 (Act 80 of 1988), which was enacted in the belief that efficiency would be achieved through competition in the markets. However, no provision was then made to compensate for the market externalities that favoured road transport, with the outcome that road transport now carries far more freight in South Africa than is justified by the resource costs of the services it supplies. The abolition of regulation has thus not brought the economic efficiency that free enterprise is intended to achieve (National Freight Logistics Strategy, 2005).”

The percentage of Cape Town Container Terminals cargo being transported by rail is less than 10%, mainly due to the poor competitiveness of rail over the short distance to the Western Cape hinterland (Havenga, et al., 2010).

In 2009, TFR started a project to upgrade its rail infrastructure and to implement a corridor strategy. The following seven corridors were identified (refer to Figure 31):

- Sishen/Saldanha iron ore corridor;
- export coal-line (via Richards Bay Coal Terminal);
- Western Cape corridor (Capecor);
- Northern Cape/Port Elizabeth corridor;
- Gauteng/Port Elizabeth corridor;
- KwaZulu-Natal corridor;
- Gauteng/Maputo corridor.

The corridor system is improving the efficiency and reliability of the rail transportation system by providing a platform for the following initiatives:

- implementing a joint planning office between TPT and Transnet Freight Rail to increase the reliability of train schedules;
- dedicating train resources per corridor;
- improving stack flow management between Transnet Freight Rail depots and the maritime ports.

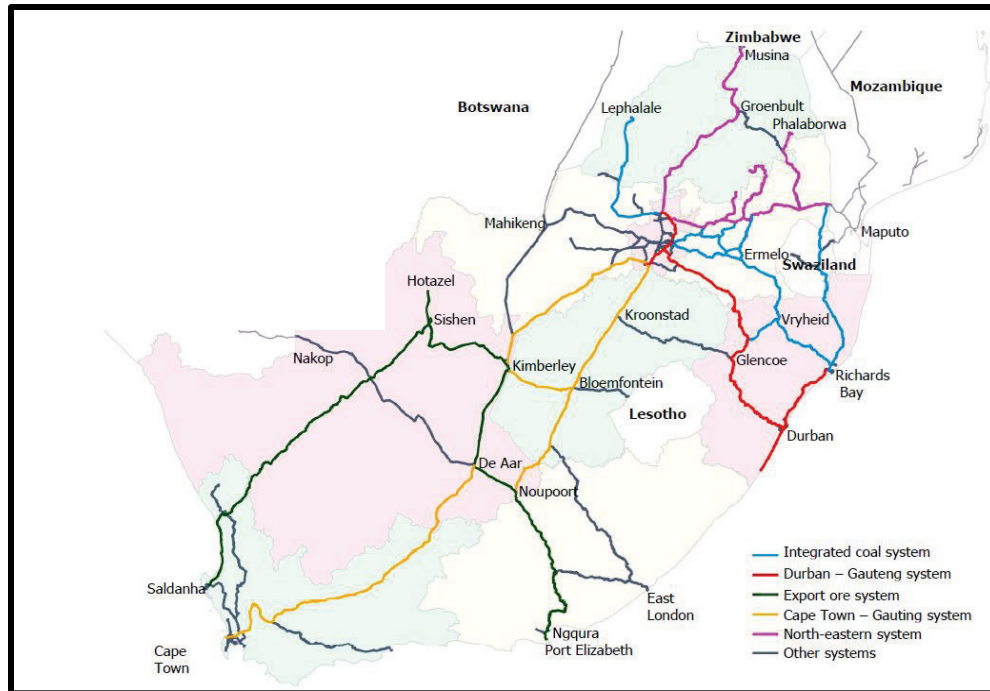


Figure 31: South African Railway Corridors (Transnet Limited, 2011)

4.8.5 Road Congestion

Road congestion is one of the main issues faced by the Port of Cape Town. The root of the problem lies with the historic development of Cape Town and the fact that the growth of the city has been directly related to the growth of the port. This resulted in the Port of Cape Town being surrounded by infrastructure that has not been, nor could have been, planned and built to accommodate the current freight- as well as commuter traffic growth rates.

The road congestion also negatively contributes to the transportation cost, because it increases the turnaround time of the trucking companies. The increased turnaround time forces the trucking companies to increase their prices to stay profitable, thereby increasing the transportation cost of cargo. This implies that by finding a solution to road congestion, the productivity of trucks would increase and the transport cost would decrease significantly, thereby making the Port of Cape Town more efficient and competitive.

4.8.6 Low Productivity

Historically, handling productivity in the Port of Cape Town has been relatively low compared to other maritime ports in the world: 14-15 containers per crane per hour compared to the international benchmark of 25 moves per crane per hour (Van Dyk, 2009). The main reasons

for this stem from the antiquated equipment and the lack of training of crane operators. However, with the new expansion of the Cape Town Container Terminal both these issues were resolved. Firstly, six new STS gantry cranes have been commissioned at the terminal and secondly, TPT has invested in a R6.7 million simulator, which is used to train crane operators for windy operating conditions (Van Dyk, 2009).

Furthermore, the low productivity of the Cape Town Container Terminal can be contributed to inclement weather conditions (refer to section 4.9 of this study).

4.9 Inclement Weather Conditions

The Port of Cape Town is situated in Table Bay, which forms part of the South African region - Cape of Good Hope. The Cape of Good Hope is also called the Cape of Storms and storms significantly affect port operations. This section of the study gives a brief overview of the weather conditions at the Port of Cape Town (i.e. in Table Bay).

4.9.1 Wave Climate

The wave climate in the Table Bay area generally consists of two (2) types of waves, namely: seas and swell.

Seas, also known as storm waves, are wind generated waves within or close to the wave generation area and exhibit a very irregular pattern. Storm waves are generally more predominant in Table Bay during the windy summer months of September to March.

In deep water, waves can travel out of the wave generation area with a minimal loss of energy, and progressively becoming more regular, smooth waves or a swell, which can travel for great distances from the area of origin. Swells are generally more predominant in Table Bay during the winter months of April to August. During this period the swell is generated by the fierce storms of the southern oceans.

4.9.2 Wave Measuring Tools at the Port of Cape Town

The seas and swell that affect the Port of Cape Town can be measured in two (2) ways, namely: global wave measurements and local wave measurements.

Global wave measurements, such as the American National Centres of Environmental Predictions [NCEP] – National Oceanographic and Atmospheric Administration, describe wave conditions at deep sea locations over the entire globe. One such NCEP grid point is located

90km south west of Table Bay (located at 34°S , 17.5°E) in water depth of approximately 400m and provides reliable historical wave data, such as Significant Wave Height (H_s), Peak Wave Period (T_p) and wave direction, for the area (refer to Figure 34).

The general annual wave rose for the NCEP grid point is shown in Figure 32 below, from which it is clear that the dominant wave direction is from South West.

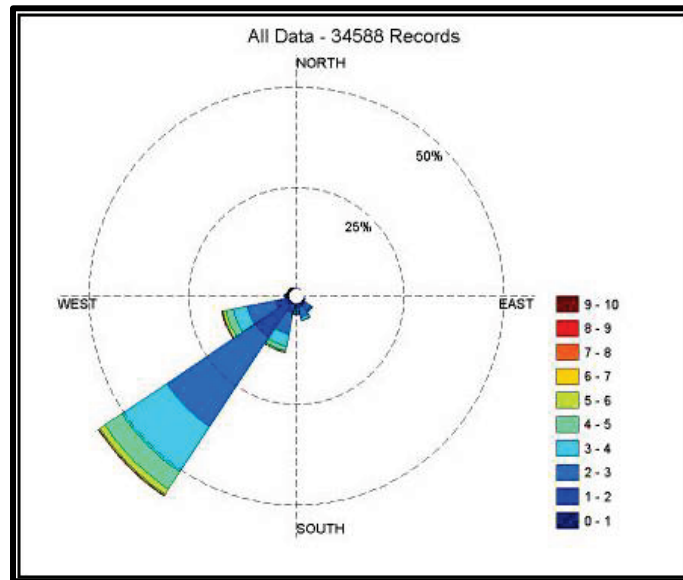


Figure 32: NCEP Grid Point Wave Rose (Rossouw, 2011)

Local wave measurements are available from the directional Waverider Buoy at Slangkop near Cape Point (refer to Figure 34). The Slangkop Waverider Buoy is located at $34^{\circ}12'14.40''\text{S}$, $18^{\circ}17'12.01''\text{E}$ in water depth of approximately 17m.

The general annual wave rose for the Slangkop Waverider Buoy is shown in Figure 33 below, from which it is clear that, similar to the NCEP grid point, the dominant wave direction is from South West.

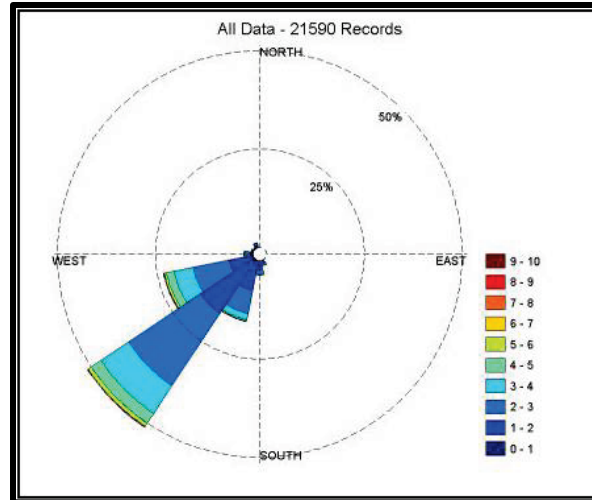


Figure 33: Slangkop Waverider Buoy Wave Rose (Rossouw, 2011)

4.9.3 Wave Refraction Study

The results (refer to Figure 34) from the global and local wave measurements can be applied in wave generation and refraction models, such as the SWAN (Simulating Waves Near-shore) model, to determine the wave climate at specific locations in Table Bay.

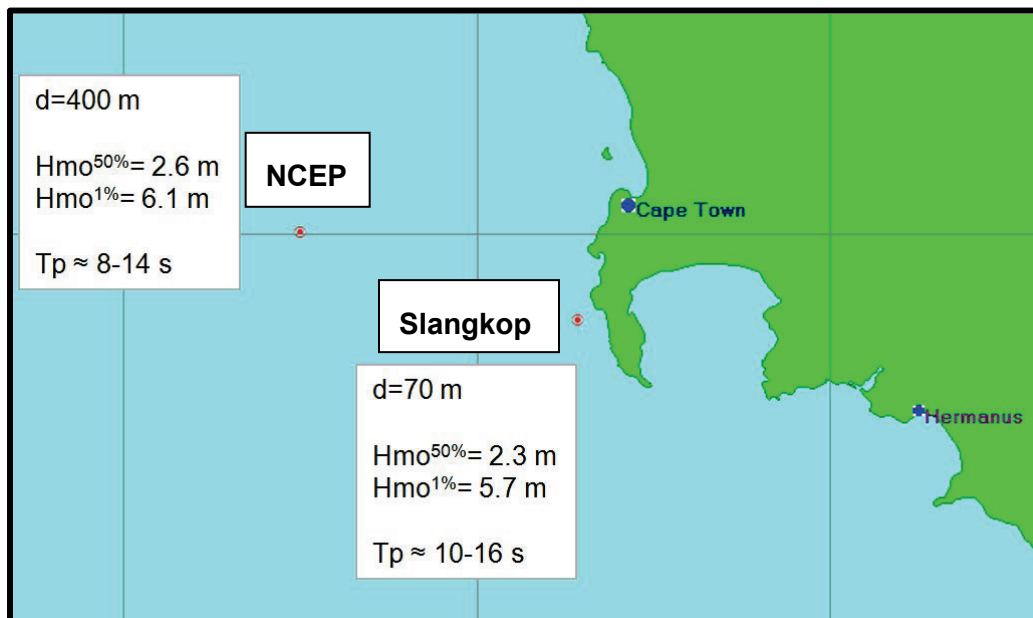


Figure 34: Wave Measurement Results (Rossouw, 2011)

The SWAN model is based on the discrete spectral action balance equation and is fully spectral (in all directions and frequency). The model computes the evolution of random, short-crested waves in coastal regions with deep, intermediate and shallow water and ambient currents.

Figure 35, Figure 36 and Figure 37 present the results of such a wave refraction study that was done by Smith & Luger (2003) for three different wave conditions. It should be noted that the study done by Smith & Luger (2003) analysed the effect of the dredge area (in the rectangle) on the wave climate in Table Bay.

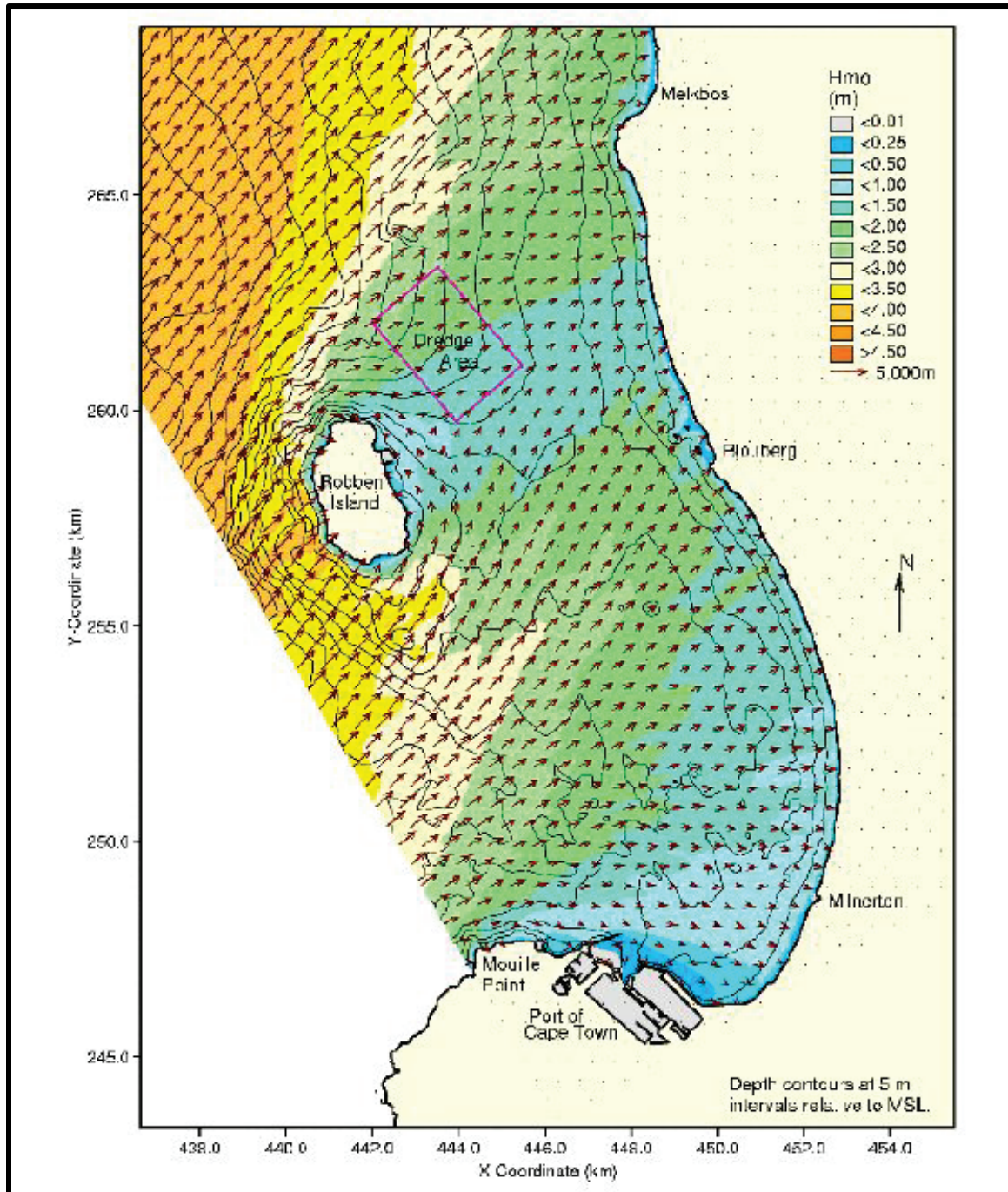


Figure 35: Refraction Study ($H=5m$, $T=12s$ and direction=SSW) (Smith & Luger, 2003)

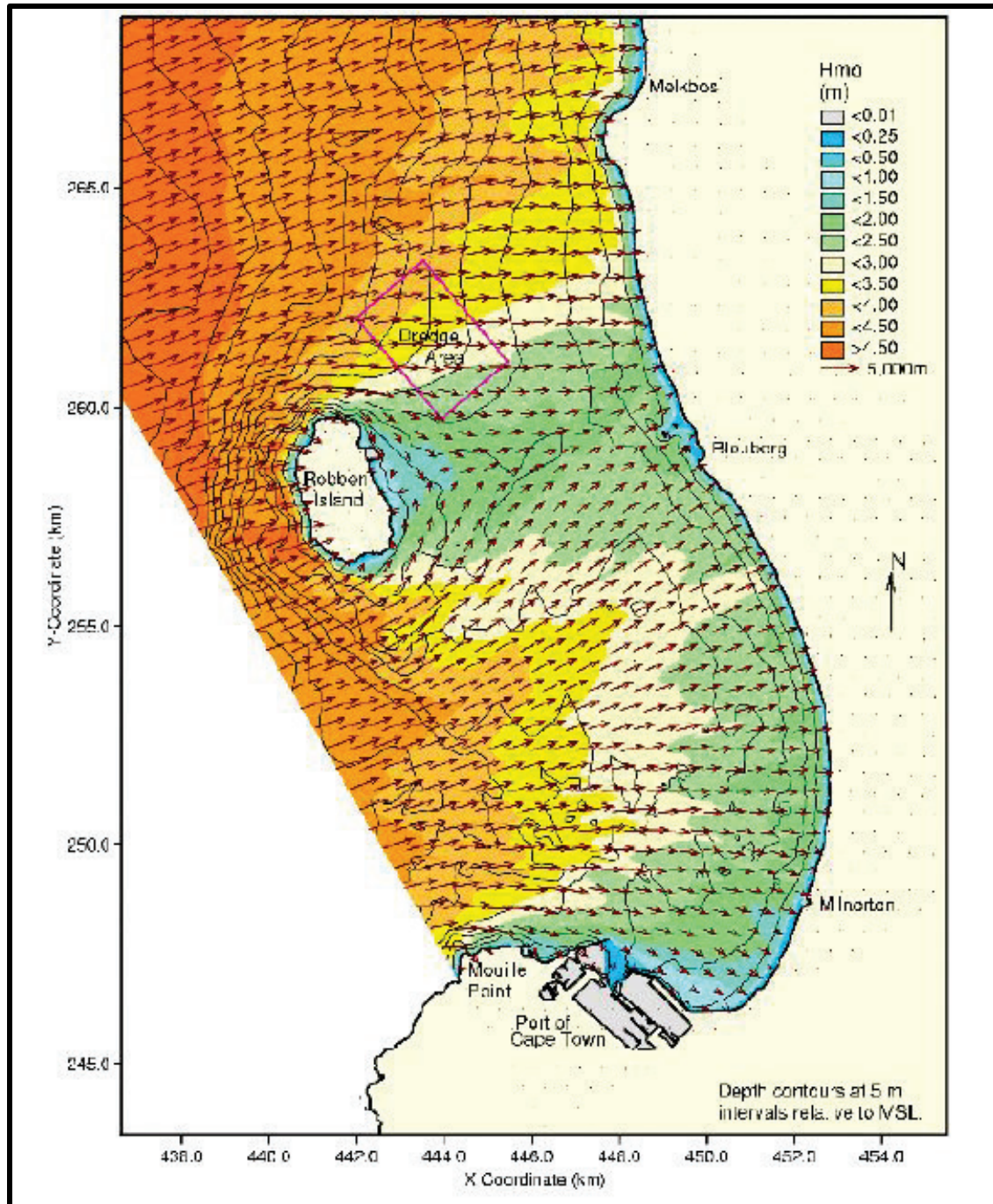


Figure 36: Refraction Study ($H=5\text{m}$, $T=12\text{s}$ and direction=WSW) (Smith & Luger, 2003)

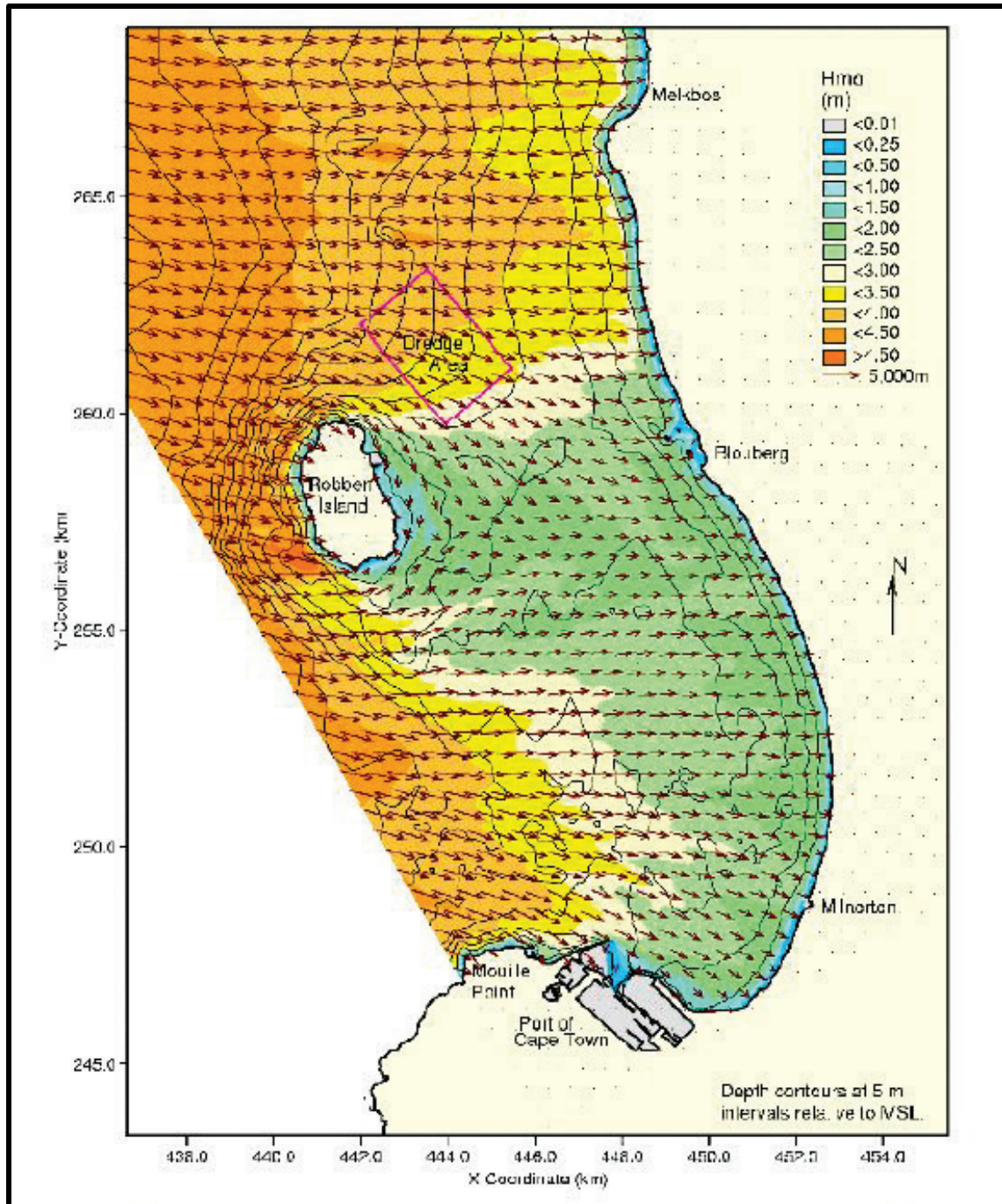


Figure 37: Refraction Study (H=5m, T=12s and direction=WNW) (Smith & Luger, 2003)

These figures show that a significant reduction in wave height occurs when the waves enter the Table Bay area. Furthermore, the figures indicate that the southern parts of Table Bay (i.e. Port of Cape Town) are sheltered from southerly wave conditions, due to the strong refraction around Mouille Point.

The Port of Cape Town has set the maximum allowable wave height for safe entry at 3m (Ruthenavelu, 2012). When conditions in the entry channel exceed this allowable maximum the pilot and harbour master determines safe entry on a case to case basis.

4.9.4 Currents in Table Bay

Table Bay lies within the southern Benguela upwelling system and circulation is mainly anti-clockwise within the bay. Surface currents are mainly wind-driven with typical velocities of 20 cm/s to 30 cm/s (Werz, 2003). Near-shore currents along the coast are wave-driven; waves approach the coast obliquely from the south-west generating northward flow.

4.9.5 Wind and Fog at the Port of Cape Town

The wind and fog are other factors that influence the productivity of the Port of Cape Town. Wind delays, at the Cape Town Container Terminal, have been known to reach 45 to 145 hours per month during the summer months, from September to March (Port Technologies International, 2010). The wind has the greatest effect on the RTG cranes and the STS gantry cranes at the Cape Town Container Terminal, because of the fact that these cranes are unable to operate in wind speed above 72 km/hour and 80 km/hour respectively.

4.9.6 Summary

The inclement weather conditions at the Port of Cape Town and specifically the Cape Town Container Terminal can be divided into four categories, namely:

- **Wave Climate:** in winter, the southern swell can stop the vessels from safely entering the port and the vessels are forced to wait outside the harbour until the swell diminishes. The waves in Table Bay contribute around 8% to the overall yearly terminal weather downtime (Richer, 2010).
- **Currents:** the currents in Table Bay are predominantly surface currents, which are wind driven with typical velocities of 20 – 30 cm/s. The overall yearly terminal weather downtime due to the currents in Table Bay is negligible (Werz, 2003).
- **Wind:** the wind has the greatest effect on the RTG cranes and the STS gantry cranes during the windy summer months of September to March. The wind at the Cape Town Container Terminal contributes around 85% to the overall yearly terminal weather downtime (Richer, 2010).
- **Fog:** the influence of fog mainly occurs during spring and contributes around 7% to the overall yearly terminal weather downtime (Richer, 2010).

In 2009, inclement weather downtime at the Cape Town Container Terminal totalled 661.71 hours, which represents 27.5 working days (Richer, 2010). Therefore, by assuming that the downtime in 2009 is a fair representation of the weather downtime at the Cape Town Container Terminal one can assume a possible overall downtime split as presented in Table 7 below.

Table 7: Overall Terminal Downtime

Description		Duration (hours)	Overall Downtime Contribution	Overall Operational Contribution
Overall Terminal Downtime		1060 ^a	100%	13.8%
Inclement Weather Downtime	Waves (8% of Inclement Weather Downtime)	52.94 ^b	5%	0.7%
	Wind (85% of Inclement Weather Downtime)	562.5 ^b	53%	7.3%
	Fog (7% of Inclement Weather Downtime)	46.31 ^b	4%	0.6%
Shift Changes and Equipment Maintenance Downtime		398.25 ^c	38%	5.2%

Note: a – Assuming the terminal can operate 22hours per day, 7days per week and 50 weeks a year.

b – Assuming the inclement weather downtime totalled 661.71.

c – Overall downtime minus the inclement weather downtime.

The wind downtime is significantly higher than the international average of 5% (Alderton, 2008), which could have a detrimental effect on the CY equipment.

Chapter 5 Capacity Limiting Characteristics of the existing Cape Town Container Terminal

5.1 Introduction

This section of the study gives an in-depth description of the Cape Town Container Terminal in terms of the current operating as well as infrastructural constraints, thereby enabling the researcher to:

- Identify the capacity limiting characteristics of the existing container terminal, through the use of the productivity metrics, identified in sections 2.8.5 to 2.8.8. These metrics were used to determine the utilization of the current infrastructure of the Cape Town Container Terminal, as well as to derive a benchmark comparison between the Cape Town Container Terminal and the United States container terminals;
- Quantify the need to expand the throughput capacity of the existing container terminal, through the use of general design guidelines identified in sections 2.8.1 to 2.8.4. These design guidelines were used to determine the maximum capacity of the current maritime port infrastructure.

5.2 Productivity Metrics

The utilization of the current Cape Town Container Terminal infrastructure was determined by using the three (3) main productivity metrics. Each of the three (3) main Cape Town Container Terminal productivity metrics was then evaluated by comparing them to that of the United States ports. The results of the United States container terminals were obtained from the study done by the Tioga Group Inc. (2010).

5.2.1 CY Capacity Utilization

The CY capacity utilization was determined by dividing the annual throughput (TEU) by the sustainable CY capacity (throughput as a percentage of sustainable capacity).

The CY capacity utilization of the Cape Town Container Terminal (phase 1 and 2) is shown in Table 8.

Table 8: CY Capacity Utilization (%)

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Annual Throughput (TEU)	800 000 ^a	1 400 000 ^b
Sustainable CY TEU Capacity	16 158 ^c	32 762 ^c
CY Capacity Utilization (%)	88	76

Note: a – Refer to Section 4.6.1.

b – Refer to Section 4.6.2.

c – Refer to Appendix C.1.1.

A comparison between the metric values of the Cape Town Container Terminal and that of the United States container terminals is presented in Figure 38.

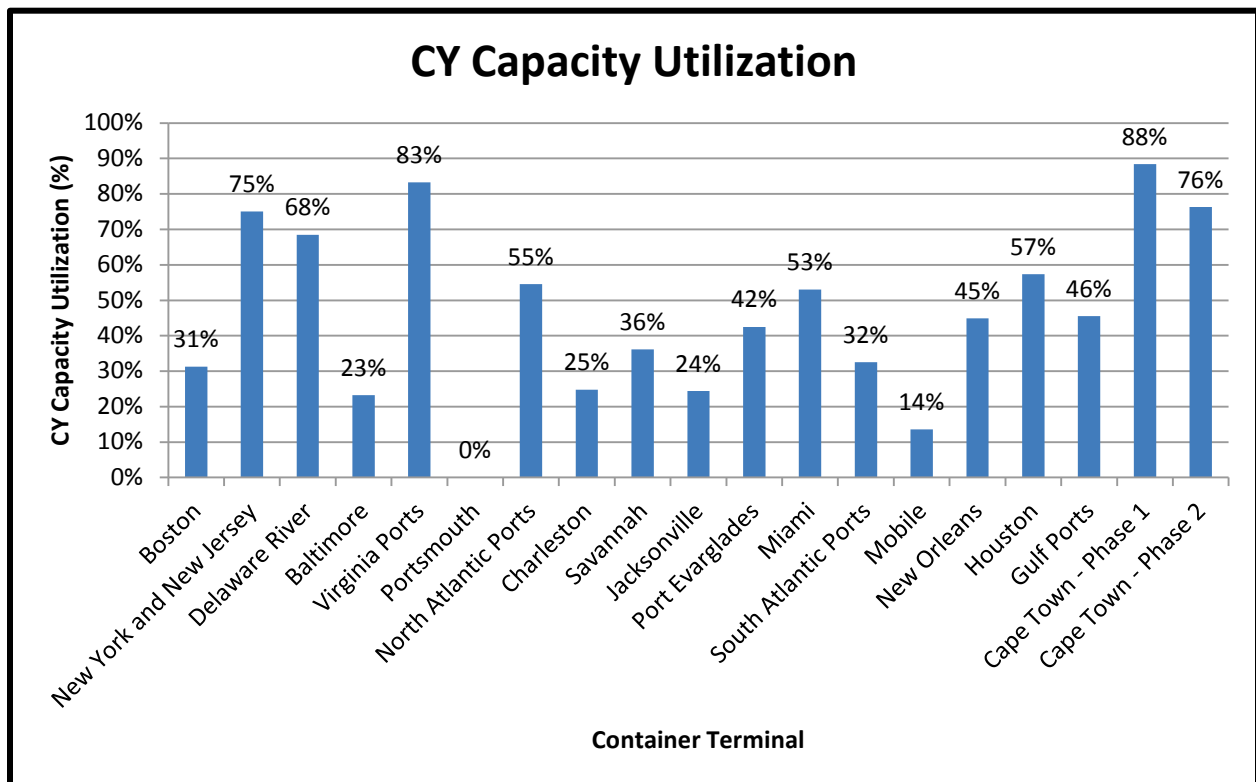


Figure 38: CY Capacity Utilization

The CY capacity utilization metric measures the capacity utilization of the container terminal yard. The CY capacity utilization of the Cape Town Container Terminal is relatively high compared to the United States container terminals (refer to Figure 38), which is expected due to the substantial latent CY capacity in the United States container terminals.

The very high CY capacity utilization values imply that the Cape Town Container Terminal would not be able to sustain the assumed throughput values of 0.8 million TEU and 1.4 million TEU per annum, respectively.

5.2.2 Container Crane Utilization

The container crane utilization was determined by dividing the annual throughput (TEU) by the annual container crane capacity (throughput as a percentage of container crane capacity).

The container crane utilization of the Cape Town Container Terminal (phase 1 and 2) is shown in Table 9.

Table 9: Container Crane Utilization (%)

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Annual Throughput (TEU)	800 000	1 400 000
Annual Container Crane Capacity (TEU)	1 386 000 ^a	2 079 000 ^a
Container Crane Utilization (%)	58	67

Note: a – Refer to Appendix C.1.2.

A comparison between the metric values of the Cape Town Container Terminal and that of the United States container terminals is presented in Figure 39.

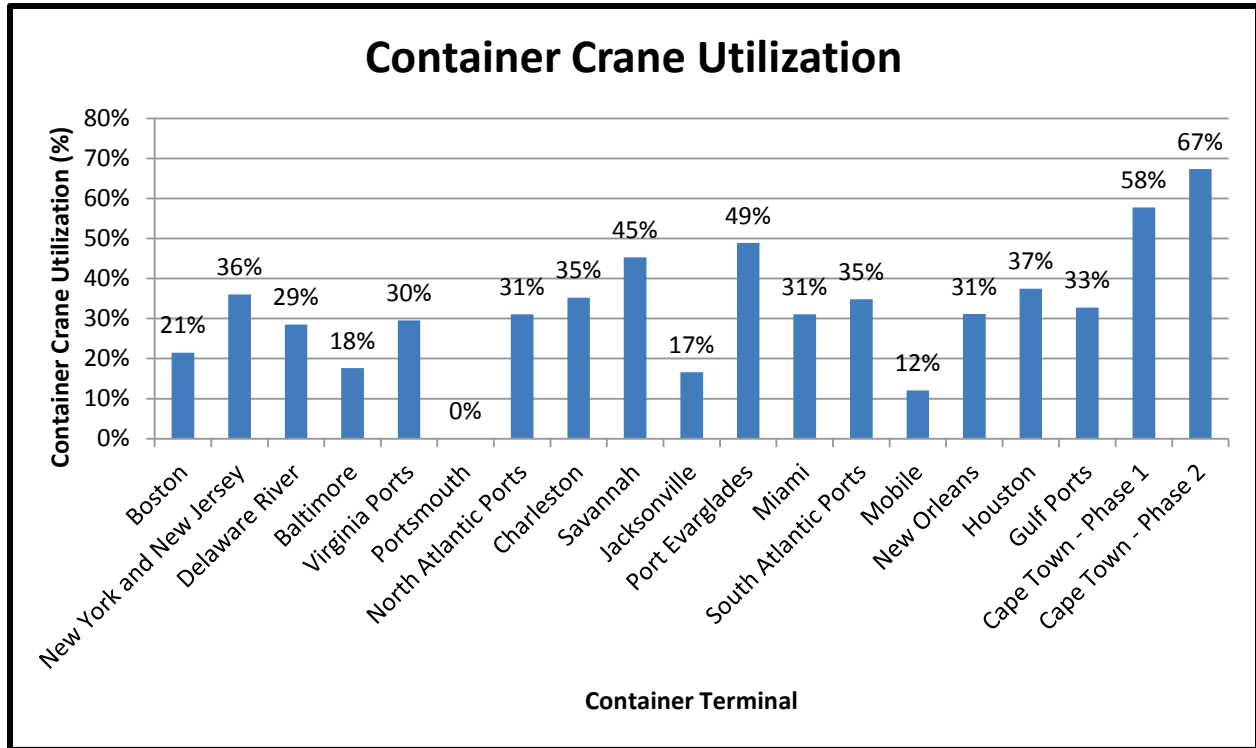


Figure 39: Container Crane Utilization

The container crane utilization of the Cape Town Container Terminal phase 2 is much higher than that of both the Cape Town Container Terminal phase 1 and the United States container terminals (refer to Figure 39), which suggests that the number of container cranes would have to be increased to accommodate the growing demand.

5.2.3 Berth Utilization – Vessel Call Basis

The berth utilization (vessel call basis) was determined by dividing the annual vessel calls per berth by the sustainable vessel calls per berth.

The berth utilization (vessel call basis) of the Cape Town Container Terminal (phase 1 and 2) are shown in Table 10.

A comparison between the metric values of the Cape Town Container Terminal and that of the United States container terminals is presented in Figure 40.

Table 10: Berth Utilization – Vessel Call Basis

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Annual Vessel Calls per Berth	139 ^a	139 ^a
Sustainable Vessel Calls per Berth	208 ^b	208 ^b
Berth Utilization (%) – Vessel Call Basis	67	67

Note: a – Refer to Appendix C.1.3.

b – Refer to Appendix C.1.4.

5.2.4 Berth Utilization - Average Vessel Basis

The berth utilization, average vessel basis, was determined by dividing the annual throughput by the annual berth capacity (average vessel basis).

The berth utilization, average vessel basis, of the Cape Town Container Terminal (phase 1 and 2) is shown in Table 11.

Table 11: Berth Utilization – Average Vessel Basis

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Annual Throughput (TEU)	800 000	1 400 000
Annual Berth Capacity (TEU) – Average Vessel Basis	1 209 858 ^a	1 895 444 ^a
Berth Utilization (%) – Average Vessel Basis	66	74

Note: a – Refer to Appendix C.1.8.

A comparison between the metric values of the Cape Town Container Terminal and that of the United States container terminals is presented in Figure 40.

5.2.5 Berth Utilization - Maximum Vessel Basis

The berth utilization, maximum vessel basis, was determined by dividing the annual throughput by the annual berth capacity (maximum vessel basis).

The berth utilization, maximum vessel basis, of the Cape Town Container Terminal (phase 1 and 2) is shown in Table 12.

Table 12: Berth Utilization – Maximum Vessel Basis

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Annual Throughput (TEU)	800 000	1 400 000
Annual Berth Capacity (TEU) – Max Vessel Basis	1 598 952 ^a	2 015 324 ^a
Berth Utilization (%) – Maximum Vessel Basis	50	69

Note: a – Refer to Appendix C.1.6.

A comparison between the metric values of the Cape Town Container Terminal and that of the United States container terminals is presented in Figure 40. For the description of the vessel call basis metric and the estimated average vessel basis metric refer to section 5.2.3 and 5.2.4, respectively.

The berth utilization metric measures the capacity utilization of the container terminal berths. The relatively high berth utilization of the Cape Town Container Terminal is similar to that of the South Atlantic and Gulf container terminal berths of the United States (refer to Figure 40). This suggests that the berths at the Cape Town Container Terminal will be operating very close to maximum capacity when the annual throughput reaches the assumed values of 0.8 million TEU and 1.4 million TEU per annum, respectively. Furthermore, the three (3) berth utilization metrics of the Cape Town Container Terminal all show similar values, which indicates that a good spread of different vessels sizes call at these berths.

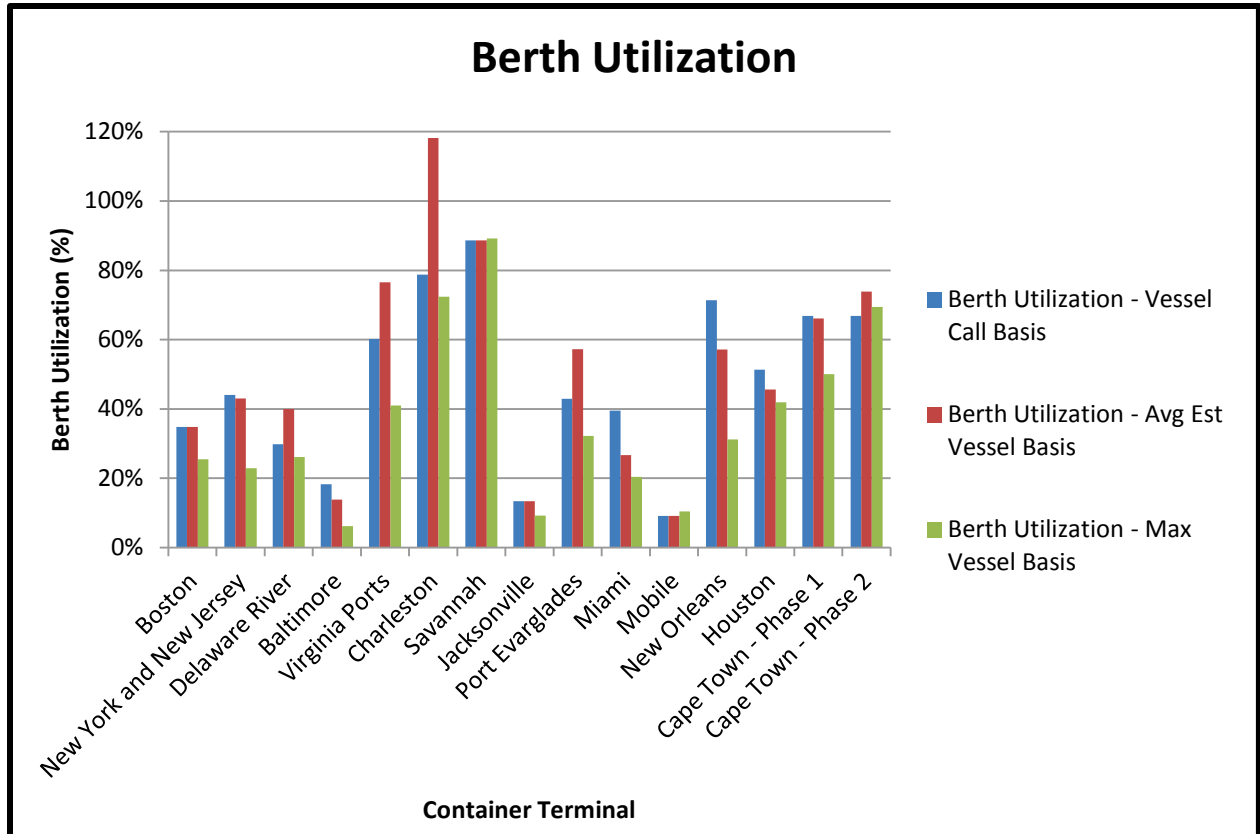


Figure 40: Berth Utilization

5.2.6 Results of Productivity Metrics

The results of the productivity metrics can be summarized in two (2) parts, namely: sustainable annual capacity and utilization metrics.

Firstly, the sustainable annual capacity of the different areas of the Cape Town Container Terminal is compared in Figure 41, which indicates the following:

- The CY capacity is the capacity limiting factor for both phase 1 and phase 2 of the Cape Town Container Terminal expansion projects (assuming that the container crane capacity could easily be increase by commissioning an additional two container cranes). Phase 2 indicates a significant improvement in the CY capacity increasing the capacity from 0.9 million TEU per annum to around 1.8 million TEU per annum;
- The increase in berth depth has increased the berth capacity – avg. and max vessel basis to 1.9 million TEU per annum and 2 million TEU per annum respectively;
- It should be noted that these capacities should only be used to compare the relative differences in capacity of the different areas of the terminal and is not an indication of the

actual capacity of the terminal. The reason for this is that these capacities do not take into account any capacity reducing factors such as delays, congestion and high dwell time, therefore depicting unobtainable capacities.

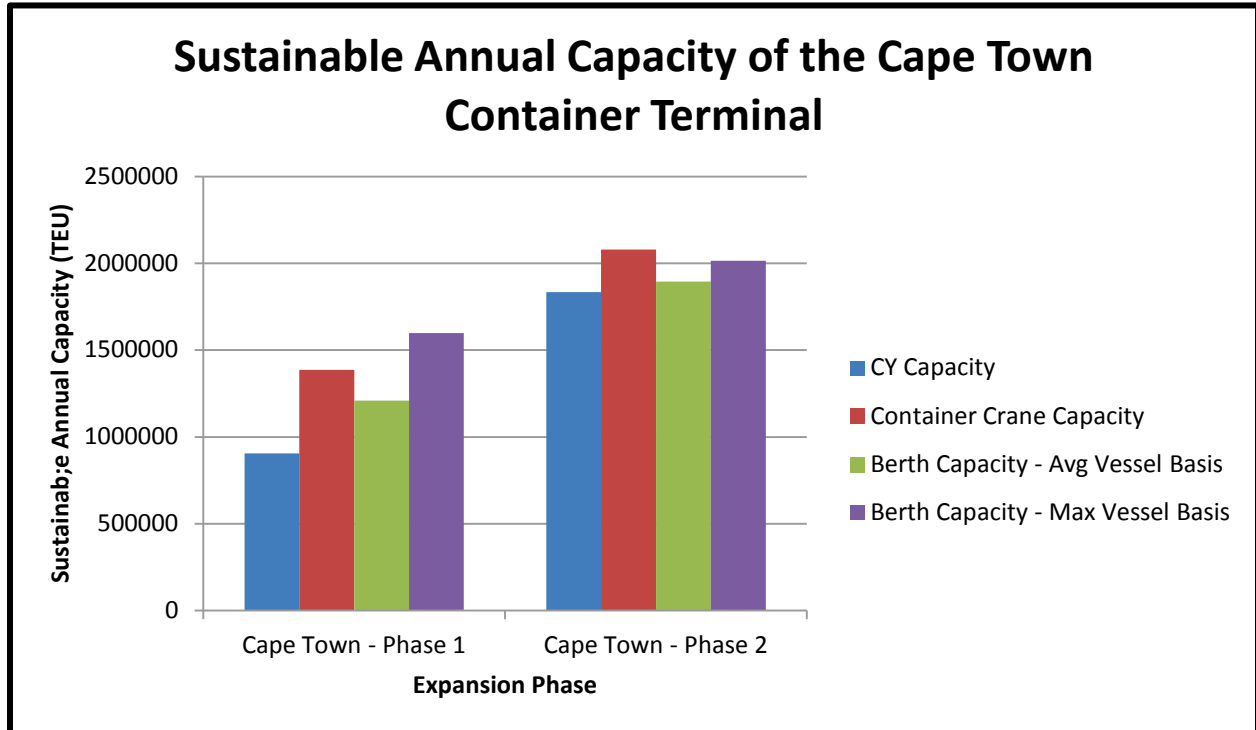


Figure 41: Sustainable Annual Capacity of the Cape Town Container Terminal

Secondly, the utilizations metrics of the different areas of the Cape Town Container Terminal indicate the following:

- The very high CY capacity utilization of the Cape Town Container Terminal phase 1 and 2 imply that the CY is the capacity limiting factor for both phase 1 and phase 2 of the Cape Town Container Terminal expansion projects (assuming that the container crane capacity could easily be increase by commissioning an additional two container cranes). Phase 2 shows a significant reduction in the utilization of the CY; however, the value is still high enough to suggest that the Cape Town Container Terminal would not be able to sustain an annual throughput of 1.4 million TEU;
- The high container crane utilization of the Cape Town Container Terminal phase 2 supports the suggestion that the number of container cranes would have to be increased to accommodate the growing demand;

- The relatively high berth utilization of the Cape Town Container Terminal is similar to that of the South Atlantic and Gulf container terminal berths of the United States. This suggests that the berths at the Cape Town Container Terminal will be operating very close to maximum capacity when the annual throughput reaches the assumed values of 0.8 million TEU and 1.4 million TEU per annum, respectively. Furthermore, the three (3) berth utilization metrics of the Cape Town Container Terminal all show similar values, which indicates that a good spread of different vessels sizes call at these berths.

5.3 General Design Guidelines

The need to expand the throughput capacity of the Cape Town Container Terminal was quantified by using the general design guidelines for container terminals, which were identified in sections 2.8.1 to 2.8.4. These design guidelines were used to determine the maximum capacity of the current maritime port infrastructure.

5.3.1 Design Vessel – Approach Channel Basis

The allowable design vessel dimensions, based on the approach channel dimensions of the Port of Cape Town, are as follows:

Table 13: Design Vessel - Approach Channel Basis

Phase	Description	Value	Reference
Cape Town Container Terminal Phase 1 and 2	Vessel Overall Length	>500m	Refer to Appendix C.2.3
	Vessel Beam/Width	68m	Refer to Appendix C.2.2
	Vessel Draft	14.9m	Refer to Appendix C.2.1

5.3.2 Design Vessel – Harbour Area Basis

The allowable design vessel dimensions, based on the harbour area of the Ben Schoeman Basin – location of the Cape Town Container Terminal, are as follows:

Table 14: Design Vessel – Harbour Area Basis

Phase	Description	Value	Reference
Cape Town Container Terminal Phase 1	Vessel Overall Length	350m	Refer to Appendix C.2.4 and C.2.6
	Vessel Beam or Width	120m	Refer to Appendix C.2.6
	Vessel Draft	13.5m	Refer to Appendix C.2.5
Cape Town Container Terminal Phase 2	Vessel Overall Length	350m	Refer to Appendix C.2.4 and C.2.6
	Vessel Beam or Width	100m	Refer to Appendix C.2.6
	Vessel Draft	15m	Refer to Appendix C.2.5

5.3.3 The Container Terminal

The Cape Town Container Terminal was evaluated with regards to the apron, primary and secondary yard areas and the hinterland and container berth capacities.

The container distribution was discussed in section 4.4.1 and can be summarized as the following:

- import volume represents 30% of the total throughput;
- export volume represents 40% of the total throughput;
- empty volume represents 30% of the total throughput.

These distributions are based on the following assumptions:

- an equal split between import volumes and export volumes, in other words a 50/50 split of container volumes;
- empty volumes consist of 40% of import volumes and 20% of export volumes.

The following infrastructural characteristics of the Cape Town Container Terminal (phase 1 and 2) were used in the evaluation of the container terminal:

Table 15: Infrastructural Characteristics of the Cape Town Container Terminal

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2	Reference
CY Area (m ²)	210 935	271 417	
Gross Area (m ²)	242 812	378 381	
CY/Gross Area Ratio (%)	87	72	
TEU Storage Slots	16 158	32 762	Refer to section 4.6
Length of Quay (m)	1 140	1 140	Refer to section 4.5

The CY and gross areas of the Cape Town Container Terminal were determined through the use of aerial photographs (including the use of Google Earth) and maps or plans obtained from TPT (Van Schalkwyk, 2011).

The gross area of the Cape Town Container Terminal (phase 2) is shown in Figure 42 below (highlighted in tan).

5.3.4 Container Terminal – The Apron

The following design guidelines were used in the evaluation of the apron:

- a) The distance from the berth line to waterside crane rail needs to be a minimum of 5m (Thoresen, 2010).
- b) The traffic area or road behind the landside crane rail and the boundary between the apron and the primary yard should be a minimum of 10m (Thoresen, 2010).

From Figure 43 it is clear that the Cape Town Container Terminal phase 2 adheres to the design guidelines stated in a) and b) above.

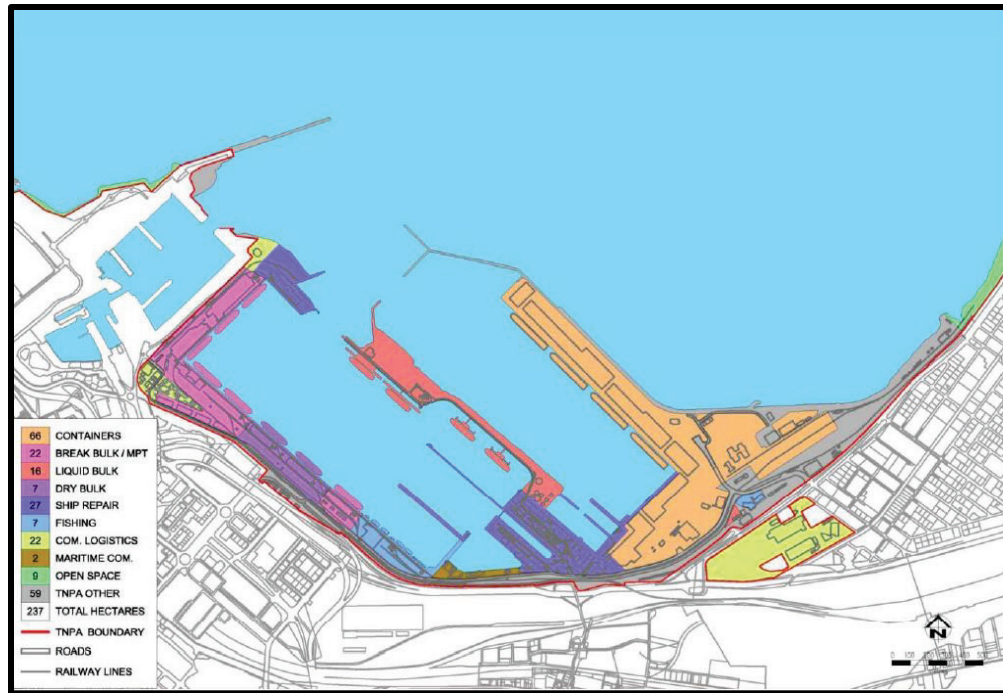


Figure 42: Cape Town Container Terminal Layout after Phase 2 (Birkenstock, 2012)

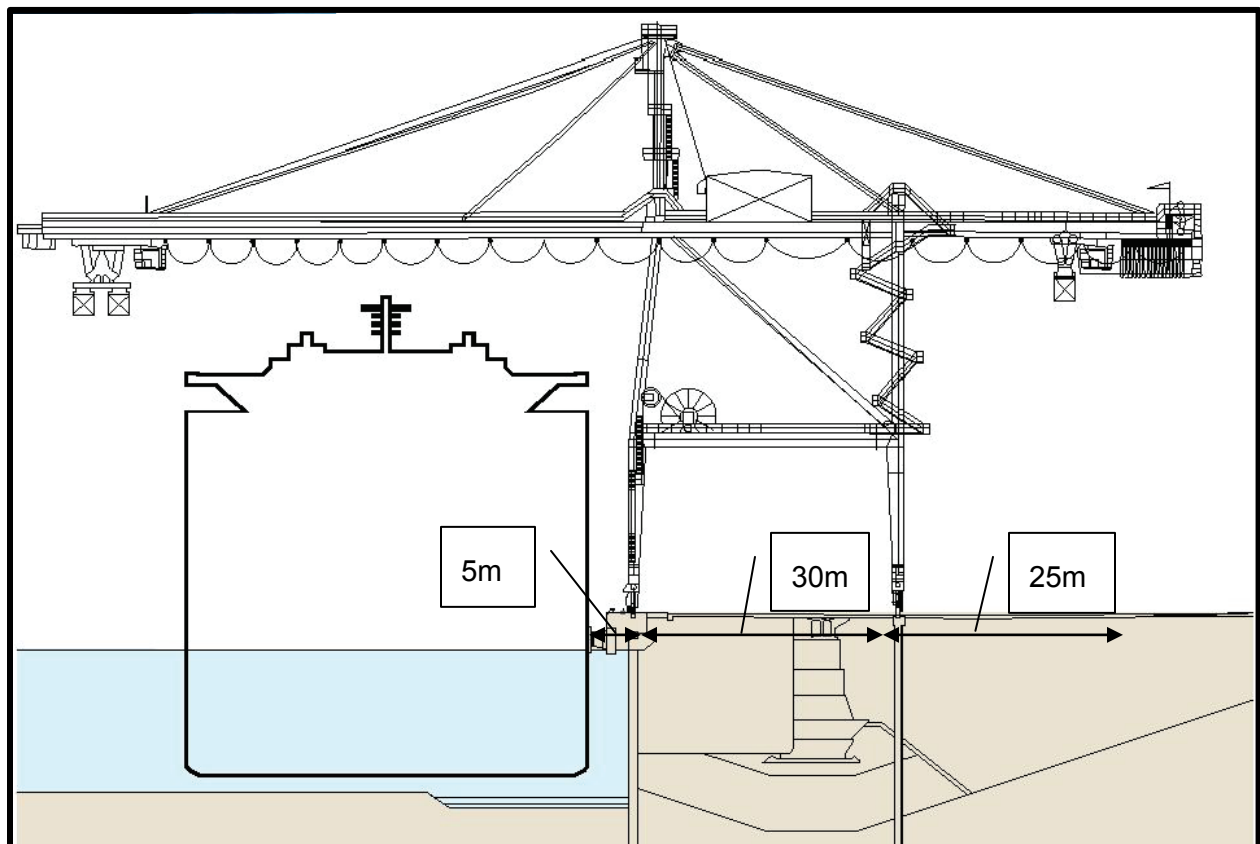


Figure 43: The Apron of the Cape Town Container Terminal – Phase 2

5.3.5 Container Terminal – The Primary Yard Area

The primary yard area of the Cape Town Container Terminal phase 1 and 2 was evaluated through the use of the design guidelines identified in section 2.8.4.

The primary yard area consists of three (3) main areas, namely: import yard area, export yard area and empty yard area. Each of these areas was evaluated by using the following equation (Thoresen, 2010):

$$A = \frac{C_{TEU} \times A_{TEU} \times D \times (1 + B_f)}{365 \times H \times L \times S} \quad (\text{Equation 1})$$

Where, A = CY area needed.

C_{TEU} = container movement in TEU per year.

A_{TEU} = area required per TEU depending on the container handling system.

D = dwell time or average days the container stays in the stacking area in transit.

B_f = buffer storage factor in front of the storage or stacking area. This varies from 0.05 to 0.1.

H = ratio of average stacking height to maximum stacking height of the containers usually varying between 0.5 and 0.8. This factor will depend on the need for shifting and digging of the containers in the storage area and the need for containers to be segregated by destination.

L = layout factor due to the terminal area varying.

S = segregation factor due to different container destinations and varies from 0.8 to 1.0.

The value of A was justified by using the following equation (Ligteringen & Velsink, 2012):

$$A = \frac{C_{TEU} \times D \times A_{TEU}}{H \times 365 \times m_i} \quad (\text{Equation 2})$$

Where, A = CY area needed.

C_{TEU} = container movement in TEU per year.

A_{TEU} = area required per TEU depending on the container handling system.

D = dwell time or average days the container stays in the stacking area in transit.

H = ratio of average stacking height to maximum stacking height of the containers usually varying between 0.5 and 0.8. This factor will depend on the need for shifting and digging of the containers in the storage area and the need for containers to be segregated by destination.

m_i = acceptable average occupancy rate. Ligteringen & Velsink (2012) suggests using a range of 60% to 75%.

The allowable container throughput capacity (C_{TEU}) of the Cape Town Container Terminal is 554 000 TEU per annum and 1 122 000 TEU per annum for phase 1 and phase 2 respectively, as calculated in Table 16 below.

Table 16: Primary Yard Area

Phase	Variable	Value				Reference
		Import	Export	Empty	Total	
Cape Town Container Terminal Phase 1	C_{TEU} (TEU/Annum)	166 200	221 600	166 200	554 000	
	$A_{Thoresen}$ (m ²)	71 218	67 827	71 218	210 264	(Thoresen, 2010)
	$A_{Ligteringen}$ (m ²)	71 219	67 827	71 219	210 266	(Ligteringen & Velsink, 2012)
	A_{actual} (m ²)				210 935	Refer to Table 15
Cape Town Container Terminal Phase 2	C_{TEU} (TEU/Annum)	336 600	448 800	336 600	1 122 000	
	$A_{Thoresen}$ (m ²)	88 761	84 534	88 761	262 056	(Thoresen, 2010)
	$A_{Ligteringen}$ (m ²)	88 761	84 535	88 761	262 057	(Ligteringen & Velsink, 2012)
	A_{actual} (m ²)				271 417	Refer to Table 15

It should be noted that the difference in the calculated and actual CY areas is due to the fact that the analysis was done based on the actual number of container TEU storage slots instead of CY areas.

5.3.6 Container Terminal – The Secondary Yard Area

The secondary yard area of the Cape Town Container Terminal (phase 1 and 2) was evaluated by using the following equation (Thoresen, 2010):

$$A_{ROL} = (A_{IMPORT} + A_{EXPORT} + A_{EMPTY}) \times (N - 1) \quad (\text{Equation 3})$$

Where, N = gross/CY area ratio, normally varies from 1.1 to 2.

The required secondary yard area of the Cape Town Container Terminal (phase 1 and 2) is 31 877m² and 106 964m², respectively (as calculated in Appendix C.2.8).

5.3.7 Container Terminal – Hinterland Capacity

The hinterland capacity was evaluated by using the following equation (Thoresen, 2010):

$$C_{BTH} = \frac{C_{TEU}}{R_{BT} \times W_W \times W_D \times W_H} \quad (\text{Equation 4})$$

Where, C_{BTH} = number of boxes between terminal and hinterland/working hours per day.

C_{TEU} = container movement in TEU per year. This should exclude the transhipped container volumes.

W_D = workings days per week.

W_H = working hours per day.

W_W = number of working weeks per year.

R_{BT} = ratio between number of boxes and the number of TEU containers, varies from 1.4 to 1.7.

The required hinterland capacity of the Cape Town Container Terminal (phase 1 and 2) is 36 container boxes per hour and 73 container boxes per hour respectively, as calculated in Appendix C.2.9. It should be noted that transshipment container volumes would normally be excluded from this calculation; however, the researcher decided to include these volumes to ensure that the hinterland has adequate capacity to accommodate growth as well as to alleviate congestion.

5.3.8 Container Terminal – Berth Capacity

The berth capacity was determined by using the following equation (Ligteringen & Velsink, 2012):

$$\text{Berth Capacity} = B_N \times c_b \quad (\text{Equation 5})$$

Where, B_N = number of berths.

c_b = average annual number of TEU per berth.

The berth capacity of the Cape Town Container Terminal (phase 1 and 2) is shown in Table 17.

Table 17: Berth Capacity

Phase	Variable	Value	Reference
Cape Town Container Terminal Phase 1	B_N	3.86	Refer to Appendix C.2.10
	c_b (TEU/berth/annum)	190 960	Refer to Appendix C.2.11
	Berth Capacity (TEU/annum)	737 106	
Cape Town Container Terminal Phase 2	B_N	3.54	Refer to Appendix C.2.10
	c_b (TEU/berth/annum)	314 160	Refer to Appendix C.2.11
	Berth Capacity (TEU/annum)	1 112 126	

5.3.9 Results of General Design Guidelines

The results of the general design guidelines can be summarized as follows: firstly, the vessel dimensions presented in Table 18 are the maximum design vessel dimensions that can be served by the Cape Town Container Terminal (phase 1 and 2), based on the physical restrictions of the approach channel as well as the harbour area of the Port of Cape Town. The design vessel dimensions identified in Table 18 are similar to the dimensions given by Transnet Limited (2011), refer to Table 1.

Table 18: Design Vessel Dimensions

Phase	Description	Value
Cape Town Container Terminal Phase 1	Vessel Overall Length	350m
	Vessel Beam or Width	68m
	Vessel Draft	13.5m
	Equivalent Vessel Capacity	5 000 TEU
Cape Town Container Terminal Phase 2	Vessel Overall Length	350m
	Vessel Beam or Width	68m
	Vessel Draft	14.9m
	Equivalent Vessel Capacity	7 000 TEU

Secondly, the allowable CY capacity of the Cape Town Container Terminal is 554 000 TEU per annum and 1 122 000 TEU per annum for phase 1 and phase 2 respectively, as calculated in Table 16. The actual container volumes for 2011 were 654 962 TEU, which implies that the CY area was already operating 18% above the design capacity of phase 1 (regarding general design guidelines). This places the operational team under considerable pressure and creates a significant risk of congestion and delays within the container terminal.

Thirdly, the required hinterland capacity of the Cape Town Container Terminal (phase 1 and 2) is 36 container boxes per hour and 73 container boxes per hour respectively, as calculated in section 5.3.7.

Lastly, the allowable berth capacity of the Cape Town Container Terminal is 737 106 TEU per annum and 1 112 126 TEU per annum for phase 1 and phase 2 respectively, as calculated in Table 17. The allowable berth capacity of the Cape Town Container Terminal phase 2 can be increased to 1 450 000 TEU per annum by commissioning two additional container cranes.

5.4 Limits of the Expansion Project

The operational and infrastructural limits of the Cape Town Container Terminal expansion project can be predicted by comparing of the annual throughput capacities (refer to Table 19) with the predicted future container volumes (refer to section 4.4), for both the Port of Cape Town and the Cape Town Container Terminal.

Table 19: Capacity of the Cape Town Container Terminal – Phase 2

Description	CY Capacity (TEU)	STS Crane Capacity (TEU)	Berth Capacity (Avg. Vessel – TEU)	Berth Capacity (Max Vessel – TEU)
Ruthenavelu (2011), refer to section 4.6	1 400 000	-	-	-
Tioga (2010), refer to section 5.2	1 834 672	2 079 000	1 895 444	2 015 324
General Design Guidelines, refer to section 5.3	1 122 000	-	1 450 000 (8 cranes) and 1 112 126 (6 cranes)	-

From the comparison one can make the following predictions: firstly, the limit of the Cape Town Container Terminal could be reached in 2020 (5% growth) or 2026 (3% growth), based on general design guideline for CY capacity (refer to dark blue line in Figure 44). These predicted dates are between five and eight years earlier than those predicted in section 4.6.3 (refer to green line in Figure 44), which were done by comparing the predicted growth rates with the annual throughput capacities as stated by Ruthenavelu (2011). The prediction assumes that the container operations in the Port of Cape Town remain the same with the Multi-Purpose and Fresh Produce Terminals handling a portion of the total throughput of the Port of Cape Town.

Secondly, the limit of the Port of Cape Town could be reached in 2018 (5% growth) or 2021 (3% growth), based on general design guideline for CY capacity (refer to dark blue line in Figure 45). These predicted dates are between seven and thirteen years earlier than those predicted in section 4.6.3 (refer to green line in Figure 45). The prediction assumes that all the container operations in the Port of Cape Town are entirely moved to the Cape Town Container Terminal.

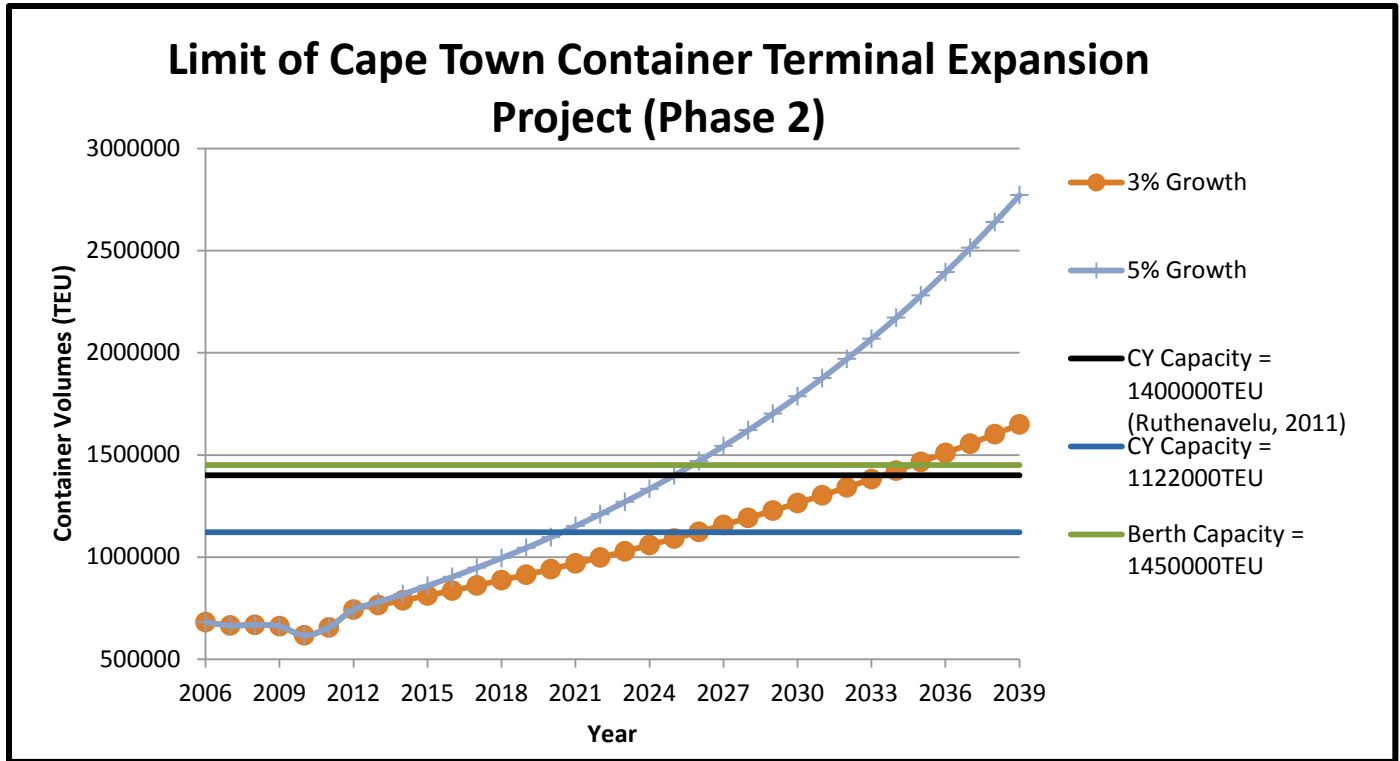


Figure 44: Limit of the Cape Town Container Terminal – Phase 2

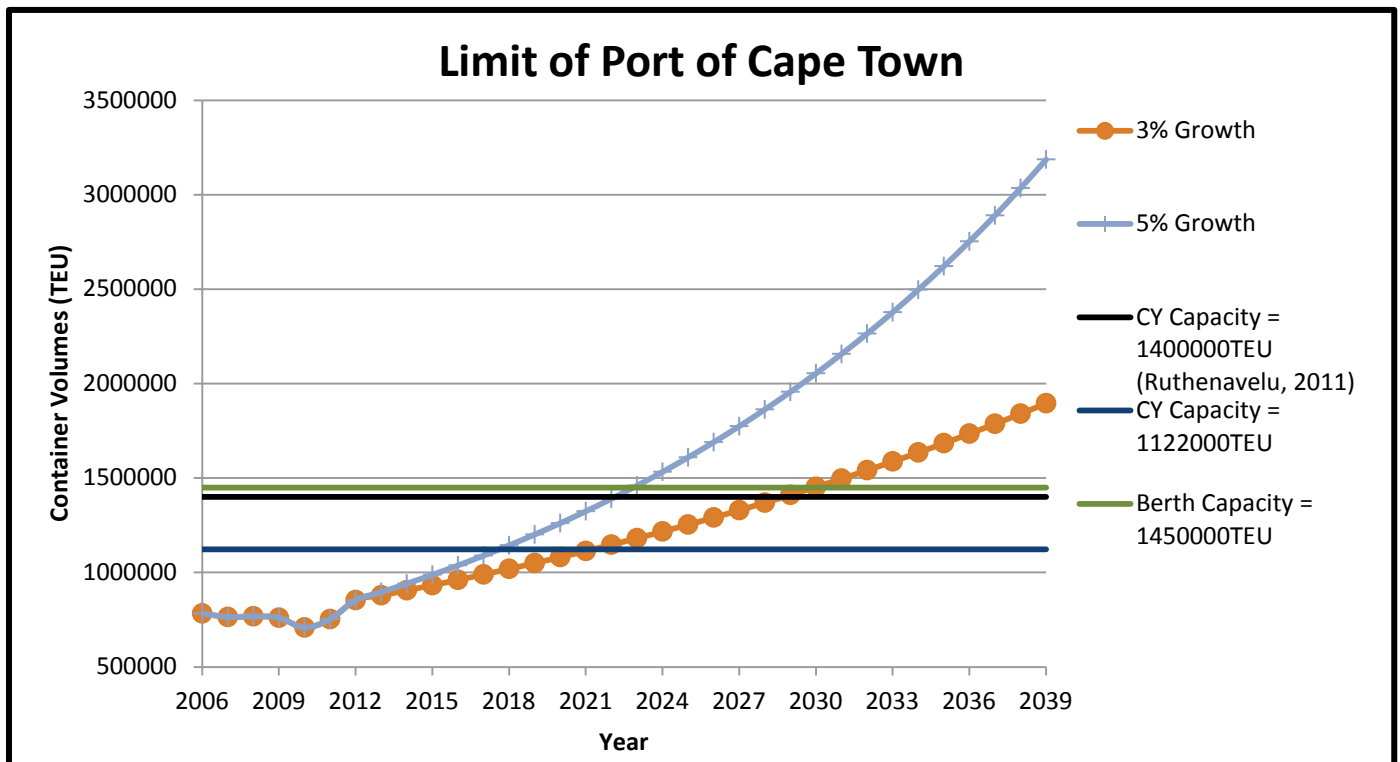


Figure 45: Limit of the Port of Cape Town

Chapter 6 South African Policy Review

6.1 Introduction

This section of this study gives a brief overview of policies that have relevance to intermodal transport, improvement of the maritime and dry ports and of the transport infrastructure.

6.2 National Policies

The White Paper on National Ports Policy (August 2002) has the vision to obtain an efficient system of ports that is seamlessly integrated into the transportation network, thereby enhancing South Africa's global competitiveness (National Department of Transport, 2002). Furthermore, the main goal of the policy is to promote intermodalism and to enable port users to access the port system in the most efficient way possible. This policy illustrates the will of the government to improve the transport sector through the implementation of intermodal (dry port) facilities.

The National Land Transportation Strategic Framework (July 2006) has the goal to promote a more balanced sharing of freight transport between road and rail modes, thereby facilitating the shift of freight from road to rail (National Department of Transport, 2006). This framework illustrates the willingness of the government to promote rail transportation, which can be achieved by the implementation of a dry port.

The National Transport Master Plan has the objective to develop a dynamic, long term and sustainable Land Use/Multi-Modal Transport Systems Framework (National Department of Transport, 2011). This master plan illustrates the willingness of the government to implement a sustainable multi-modal transportation system as well as to promote the development of transportation corridors.

6.3 Provincial Policies

The Western Cape Provincial Spatial Development Framework (Nov 2005) has the goal determine the best share of transport models (rail and road) for long-term future freight and passenger needs of the Province (Western Cape Department of Environmental Affairs and Development Planning, 2005). This framework illustrates the willingness of the government to promote rail transportation as well as to promote the development of transportation corridors.

The Western Cape Urban Freight Traffic Study (September 2006) has the vision to determine the impact of road freight on the Cape Town transportation systems. This study suggests that the transportation system adopts the following strategies (Western Cape Department of Transport and Public Works, 2006):

- Staging container vehicles off-site from the maritime container terminal;
- Using rail to transport containers to and from the maritime port.

This study illustrates the willingness of the government to promote rail transportation to the Port of Cape Town, thereby significantly reducing road congestion. Furthermore, the recommendations of this study all support the development of a dry port.

The Integrated Transport Plan 2006-2011 (June 2006) has the vision to develop a safe and efficient freight transport system, by aligning port development and operations with freight flow demand patterns and ocean freight trends (City of Cape Town, 2006). This plan illustrates the willingness of the government to promote an intermodal transportation system, including a dry port, which is reliable and efficient.

The Port Master Plans (April 2007) identified the following guiding principles for future development in the ports of Cape Town, Mossel Bay and Saldanha (Transnet National Ports Authority, 2007):

- optimize capital investment in order to meet the long term national demand;
- maintain flexibility in order to respond to changing technologic and economic conditions;
- minimize the disruption of existing port activities during implementation;
- ensure adequate provision for all non-freight port services and facilities.

This master plan illustrates the willingness of Transnet to provide a reliable and efficient transportation service, as well as the development of transportation corridors.

6.4 Conclusion

All of the abovementioned policies showed that both the South African and Western Cape Government encourage the improvement of the infrastructure and the efficiency of the transport system in South Africa and the province. Furthermore, these policies support the notion of implementing the dry port concept as a feasible alternative for expanding the throughput capacity of the Cape Town Container Terminal.

Chapter 7 Dry Port - Solution to Overall Capacity Limit

7.1 Introduction

The definition of a dry port, as defined in section 2.3.1, implies that the dry port concept includes the notion that some of the facilities at maritime ports could be duplicated or complemented at inland locations. Through this notion, economic development and logistics integration (consolidation of services) are promoted and the demands on limited capacity (land and access) at the maritime ports are reduced.

The dry port concept has therefore become appealing to the following stakeholders:

- **Port authorities:** due to the influence of increased port-area land value and limited adjacent warehousing and distribution facilities;
- **Shippers and logistics managers:** due to the provision of consolidated services at one location;
- **Regional community:** due to the ability of a dry port to promote local and regional development, which is accomplished by providing jobs in the direct processing of international trade and attracting distribution and manufacturing industries to the region.

This section of the study focuses on the possible implementation of a dry port in the regional supply chain of the Western Cape, with the aim of providing the Cape Town Container Terminal with a feasible alternative for expanding its throughput capacity.

7.2 Operational Characteristics of a Dry Port

The following sections give a brief overview of the operational characteristics of a dry port, with focus on the supply chain of the Western Cape.

7.2.1 Operational Procedures in Dry Ports

Dry port operations are generally similar to that of inland container terminals, except that dry ports offer customs clearance services. Trainaviciute (2009) describes the operational procedure of an intermodal transportation network containing a dry port as follows (refer to

Figure 46 below): for exported cargo, the network originates at the shippers' warehouses where the cargo is either containerized or palletized. Subsequently the cargo is transported, by truck, to a dry port where customs formalities and further containerization take place. From the dry port the cargo is transported, by road or rail, to the maritime port of departure where cargo is shipped to other maritime ports. It should be noted that all charges are collected at the dry port, as well as that all customs procedures are completed at this point and the exporters or importers do not need to perform any customs activities at the maritime port. On the maritime port of reception side of the network, the reverse of this procedure applies.

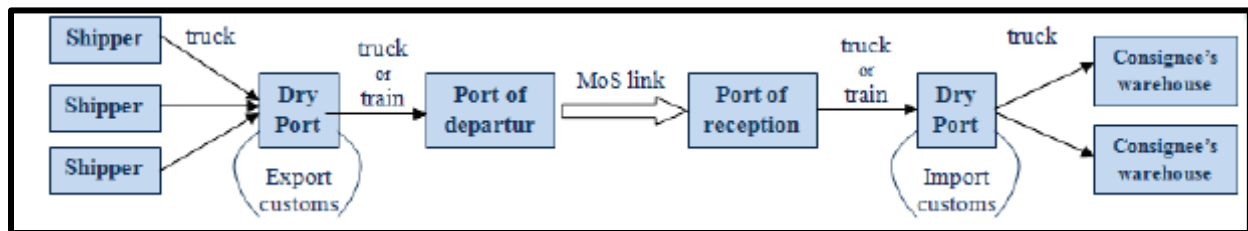


Figure 46: Transport Chain with Dry Port (Trainavičiute, 2009)

7.2.2 Modes of Transport Servicing a Dry Port

The research done by Piyapatroomi, Bunker & Ferreira (2006) identified three modes of transportation for servicing a dry port, namely:

- **Rail to dry port and road to maritime port:** provides the most cost effective and quickest way of transferring goods to the maritime port if the daily cargo volumes are small, but this mode of transport requires frequent delivery and the distance should be less than 300 km.
- **Road to dry port and rail to maritime port:** is only cost efficient for full train volumes and require an efficient rail shuttle system (refer to section 7.2.4).
- **Road to both dry and maritime ports:** if cargo volumes are not large enough for train movement, road transport is a preferred mean of transferring goods from dry ports to maritime port.

From the above it is clear that the modes of transport that could be used at a dry port in the Western Cape supply chain heavily depends on the location thereof as well as the magnitude of the potential generated sustainable container volumes. The researcher found that the most likely system that would be viable in the Western Cape supply chain would be:

- **Rail and road to dry port and rail to maritime port:** the system would make use of road transport for local producers, rail transport for regional producers (which will be driven by the railway initiatives described in section 7.2.3) and a rail shuttle that forms a direct link between the dry port and the maritime port (refer to section 7.2.4).

7.2.3 Railway Initiatives

The following railway initiatives will play a key role in the successful implementation of a dry port in the Western Cape by providing the driving force required to promote railway transportation in the region:

- **‘Cape Gateway’ Initiative:** The ‘Cape Gateway’ initiative is a container train initiative that operates on the Cape Town-to-Gauteng corridor (refer to section 4.8.4). The initiative runs two shuttle train services, one between the Belcon Transnet Freight Rail Terminal and the Port of Cape Town and a separate service between Belcon and the City Deep terminal (Johannesburg). The “delinking” of the two train services enables the operators to maximize the utilization of rolling stock. The main aim of this initiative is to reduce the travel time between Cape Town and Johannesburg from around 50 hours to 36 hours, and consequently increasing the competitiveness of railway transportation between these two cities (Van Dyk, 2009).
- **‘Tonnage off Tar’ Reefer Train Initiative:** In 2008 the initiative operated 24 trains, each carrying 38 reefer containers with avocados and citrus, from Tzaneen to Cape Town (Van Dyk, 2009). The initiative is also in the process of expanding to include trains from Kakamas, Hexriver Valley, Paarl, Elgin, Gouda and Polokwane. This initiative provides direct interaction between the maritime container terminal and the train services and allows the containers to arrive at the maritime container terminal after the stack closing time, which significantly reduces the cargo drayage time.

7.2.4 Required Efficiency of a Rail Shuttle System

The efficiency of the train shuttle system (between the dry port and the maritime port) is probably one of the most important aspects of the dry port concept and can be detrimental to the success of a dry port.

The efficiency of the train shuttle greatly influences the lead-time in the supply chain and a balance needs to be obtained between the following:

- the reduction in lead-time due to the loading and off-loading of cargo away from the congested maritime port;
- the increase in lead-time due to the effective double handling of cargo (once at the maritime port and a second time at dry port).

The main factors influencing the lead-time, and hence the efficiency of the shuttle system, are the following:

- the distance between the dry port and the maritime port;
- the shuttle infrastructure, which greatly influences the operating speed of the shuttle;
- the capacity of the shuttle system, which includes the shuttle itself as well as the loading and unloading equipment;
- the utilization of the railway, which greatly influences the profitability of the shuttle system. This is driven by the fact that a railway needs to be operated at a high utilization to be sustainable;
- the operational management of the shuttle system.

According to Richer (2010) the effect of the first four factors can be kept to a minimum if the dry port is located within a 50km radius of the maritime port, thereby ensuring that the success of the shuttle system is mostly dependent on the operational management thereof.

7.2.5 Advantages & Disadvantages of a Dry Port

The implementation of a dry port in the transportation network has the potential create an efficient and environmentally sound transportation corridor. The benefits that could result from such an efficient and environmentally sound corridor are:

- the distribution of trade traffic over the entire system, rather than concentrated at the maritime port, which could result in significant savings for shippers and daily users;
- the capacity to shuttle short haul cargoes to and from the dry port, located in the outer metropolitan area, could greatly relieve the pressure experienced by maritime port operators due to the port terminal space constraint;

- the maritime port could potentially avoid the grounding of import containers, which could reduce the peak demand on the maritime terminals caused by the large volumes of import containers arriving by ship.

The above mentioned benefits can only be achieved if the transportation planners of the Western Cape supply chain shift some of their focus away from directly improving the maritime port to improving the transportation corridors. The dry port concept is a medium for improving these corridors and the policies listed in Chapter 6 demonstrate the willingness of planners and policy makers to apply this holistic perspective to supply chain planning.

The introduction of a dry port facility into the transportation corridor adds an additional node to the supply chain and may negatively affect the efficiency of the railway system in the following ways:

- railway operators are generally reluctant to “stop the train” at an inland node, because it reduces the efficiency of their overall operation;
- the ideal situation is to always transport fully loaded containers between the maritime container terminals and the market of origin or destination. The dry port increases the risk empty equipment movement.

These impacts can, however, be mitigated through careful planning, proper management and cooperation among the supply chain participants.

7.3 Critical Needs for the Success of Dry Ports

The four types of dry ports identified in section 2.4 each have several elements necessary for success. The seven critical needs identified by this study are (also refer to section 2.7):

7.3.1 Volume

For a dry port to be viable it needs to be located in a cargo catchment area that generates sufficient demand to be able to create the economies of scale needed for cost effective operations. Piyapatroomi, Bunker & Ferreira (2006) identified that a dry port needs to handle volumes in the order of 10 000 to 20 000 TEU per annum to be viable and more than 20 000 TEU per annum to be profitable. These volumes are needed to offset the additional costs (monetary and risk) associated with the extra transshipment point introduced by a dry port. The authors also noted that chronic congestion (road, rail or on-dock) needs to be present in the existing system for the dry port concept to be successful.

The Western Cape supply chain should be able to adhere to the critical need of 'Volume' based on the following: firstly, section 7.4 identified that a dry port in the Western Cape could potentially attract an annual throughput of 0.7 million TEU by 2039, which is significantly more than the required 20 000 TEU per annum needed to be profitable. Secondly, Chapter 4 identified that the current Western Cape transportation network is under severe pressure and that road, rail and on-dock maritime port congestion is present during peak operating hours.

7.3.2 Distance

Traditionally regional intermodal terminals, such as dry ports, served by rail, needed to be located approximately 250-300km away from the maritime port to be able to compete with road transport. This is due to the fact that road transport has low fixed cost compared to that of rail transport. However, the escalating and volatile fuel costs are leading shippers to re-evaluate their long-term reliance on trucking and search for more economical long-term solutions, which are steadily improving the competitiveness of intermodal rail service (i.e. long- and short-haul rail shipping). Furthermore, the world is putting more and more pressure on the transportation sector to reduce its carbon footprint. The dry port concept gives the transportation sector the opportunity to reduce the risk of road congestion by providing a rail connection and therefore reducing its carbon emissions.

The Western Cape supply chain should be able to adhere to the critical need of 'Distance' based on the following: firstly, the Port of Cape Town forms a direct link between international trade and about three (3) million consumers in the Western Cape region. Through the direct link, the Port of Cape Town facilitates most of the trade in the Western Cape. It is an important medium for both goods destined for overseas markets as well as those coming in to shore up the region's economy. Secondly, a large portion of the Port of Cape Town's cargo catchment area is located within the Western Cape Province (approximate radius of 400km from the maritime port) and is equipped with a railway network that could potentially serve the entire cargo catchment area.

7.3.3 Initial Investment

The initial investment cost of land and dry port infrastructure can become significant and the lack thereof can be a considerable hindrance for the success of such a facility. The following three initial investment opportunities exist:

- **Greenfield:** requires full investment in all infrastructure at the terminal site, including rail and terminal infrastructure, therefore more capital is required for this type of investment opportunity. The Kraaifontein Area site is an example of such a site (refer to section 7.6.1);
- **Brownfield:** requires minimal upgrade of existing rail infrastructure and full investment in terminal infrastructure. Brownfield sites are the most common type of investment opportunity used for dry port implementation. The Ysterplaat Air Force Base and the Bellville Precinct are examples of such a site (refer to section 7.6.1). It should be noted that the presence of the Belcon facility at the Bellville Precinct could further reduce the required investment in terminal infrastructure;
- **No Rail Capital:** assumes existing rail infrastructure is in reasonable condition with adequate remaining operational life, and requires full investment in terminal infrastructure. A no rail capital type of investment opportunity is very seldom possible, due to the lack of adequate rail infrastructure;
- It is important to note that significant initial investment can be limited by adopting a phased development approach.

The development of a Brownfield site will be the most viable for the development of a dry port in the Western Cape region due to the following: firstly, the dry port concept is still a relatively new concept in Africa and, therefore, the large capital investment required to develop a Greenfield site will be unfeasible. Secondly, the rail infrastructure in the region will have to be upgraded to be able to accommodate the potential cargo volumes generated by the implementation of a dry port, especially the direct link between the dry port and the maritime port.

The presence of Transnet, which owns and operates the maritime ports and the railway network, should further improve the feasibility of such a project due to the possibility of a holistic planning regime and the availability of national funding.

7.3.4 Seasonality

A key factor in the success of a dry port is to be able to generate sustainable cargo volumes throughout the year. Therefore, if a dry port is targeting to serve markets with seasonal fluctuation it is necessary to attract complementary cargoes. The attraction of complementary cargo volumes enables dry ports that serve agricultural and horticultural markets to offset the high fixed running cost during the offseason. This ensures that the dry port is viable and can produce significant profit.

In the Western Cape region a significant portion of the market consists of agricultural and horticultural products and the effect thereof would have to be taken into account when determining the feasibility of the implementation of a dry port in the region. The dry port will have to provide value added services to attract sufficient complementary cargo volumes to remain profitable throughout the year.

7.3.5 Synergy

For a dry port to be viable there needs to be synergy between the provincial and national authorities, the transport community and the local community.

Firstly, the provincial and national objectives for economic and social development need to support the implementation of the dry port concept, because the planning process of a dry port is long and complex. This enables the implementation of the right solution at the right time and improves the viability of such a solution.

Secondly, the support of traditional transport community, i.e. the shipping lines or terminal operators, is needed to facilitate international trade and the transport community have to buy into the new operational procedures of the dry port concept.

Lastly, the support of the community is required in order to facilitate the implementation of a dry port. This reduces residents' resistance, due to the communities' perceived perception of the risk of increased pollution and environmental impacts.

Synergy is a crucial success factor in the Western Cape transportation network, because of the unique South African situation where a state-owned company, namely Transnet, owns and operates not only all the maritime ports but also the entire railway network (including locomotives and wagons). Transnet has already identified the need for synergy within the company and have created bridging teams between entities to ensure adequate coordination within the group. The bridging initiative should greatly improve the efficiency of the South African intermodal transport network as well as increase the feasibility of the dry port concept.

7.3.6 Location

For a dry port to be viable it needs to be located far enough away from congested maritime port areas to be able to consolidate sufficient real estate for initial and future warehousing and distribution facilities. Furthermore, the dry port needs to be located close enough to be able to serve the local market and achieve optimum transportation asset utilization.

The implementation of a dry port in the Western Cape supply chain will only be viable if the dry port is located within the greater Cape Town area, however it should be located outside the City of Cape Town's Central Business District. This should ensure that the dry port overcomes the inefficiencies of the overall supply chain, i.e. addressing capacity by providing a large piece of land that can accommodate growing volumes and providing the required equipment and trained staff to increase productivity.

7.3.7 Access to transportation infrastructure

By definition a dry port forms part of a transportation network and, therefore, it is critical for a dry port to have access to transportation infrastructure. Firstly, the dry port needs to have direct access to maritime ports, preferably through a dedicated rail connection. And secondly, the dry port needs to have adequate access to rail and road transportation infrastructure to be able to receive and distribute cargo from and to the target markets.

The implementation of a dry port in the Western Cape supply chain will only be viable if the dry port is located in close proximity to the N1 and N2 national freeways as well as the Cape-Gauteng railway corridor.

7.4 Estimated Container Volumes

The two main functions of a dry port are international trade processing and congestion relief, which is achieved through the duplication and supplementation of the maritime port facilities at an inland location. It should be noted that the dry port would not double nor replace the capacity of the maritime port, but would rather act as a supplementary node in the supply chain that strengthens the position of the maritime port.

Based on the above statement one can assume that any future container volume demands that exceed the CY capacity of the maritime container terminal could be absorbed by a dry port. Therefore one can predict the following dry port capacity requirement for the year 2039 (refer to Table 20):

Table 20: Dry Port Capacity Requirements

Description	Demand in 2039 (TEU per annum)	Maritime Container Yard Capacity (TEU per annum)	Dry Port Capacity Requirement (TEU per annum)
3% Growth, Cape Town Container Terminal	1 600 000 ^b	1 122 000 ^a	478 000
3% Growth, Port of Cape Town	1 900 000 ^c	1 122 000 ^a	778 000
5% Growth, Cape Town Container Terminal	2 700 000 ^b	1 122 000 ^a	1 578 000
5% Growth, Port of Cape Town	3 200 000 ^c	1 122 000 ^a	2 078 000
Berth Capacity	1 450 000 ^d	1 122 000 ^a	328 000

Note: a – Refer to Section 5.3.9.

b – Refer to Figure 44.

c – Refer to Figure 45.

d – Refer to Table 19. It should be noted that this figure is the berth capacity of the Cape Town Container Terminal and not the demand in 2039.

The following assumptions can be drawn from the dry port capacity requirement presented in Table 20: Firstly, based on a growth rate of 5% the dry port capacity requirements in 2039 would be 1 578 000 TEU and 2 078 000 TEU for the Cape Town Container Terminal and the Port of Cape Town respectively. These requirements are however highly unlikely, because under the current operational setup it would be unrealistic to assume that the dry port will handle higher volumes than the maritime port. The Cape Town Container Terminal and its berths would therefore have to be significantly altered to accommodate a growth rate of 5%.

Secondly, based on a growth of 3% and the current berth capacity it can be assumed that the dry port capacity requirements in 2039 would be between 328 000 TEU and 778 000 TEU.

These requirements are similar to that of Havenga et al (2012), who predicted that an inland terminal (Dry Port) in the Western Cape area could attract up to 723 121 TEU per annum in 2041.

Lastly, for the purpose of this study it is assumed that the Dry Port would have to be able to accommodate a maximum throughput of 0.7 million TEU per annum in 2039, which was used to determine the main size characteristic of the dry port (refer to section 7.5).

7.5 Size Characteristics of the Required Dry Port

7.5.1 The Terminal Area

The terminal area characteristics for the dry port were determined by using the following design guidelines that were identified in sections 2.8.1 to 2.8.4:

- **Container Distribution:** The container distribution of the dry port will be similar to that of the maritime port and therefore the container distribution, as discussed in section 4.4.1, would apply to the dry port. It should be noted that the presence of a dry port in the supply chain could redistribute the modal split of the current cargo volumes; however, the effect of this redistribution on the supply chain as a whole was not considered in this study.
- **The Primary Yard Area:** The primary yard area of the dry port will consist of four (4) main areas, namely import yard area, export yard area, empty yard area and container freight station (CFS) area. The required import, export and empty container yard areas as well as CFS area is calculated in Appendix D.1. Furthermore, the required amount of storage slots of the dry port is calculated in Appendix D.2.
- **The Secondary Yard Area:** The required secondary yard area (which includes the entrance facility, parking, office buildings and customs facilities) of the dry port is calculated in Appendix D.3.
- **Terminal as a whole:** The two (2) design guidelines were used for the evaluation of the terminal as a whole, namely: total land area and hinterland capacity (refer to Appendix D.4 and D.5 respectively).
- **The CY Capacity Utilization:** Determined by dividing the annual throughput (TEU) by sustainable CY TEU capacity (throughput as a percentage of capacity). The CY capacity utilization of the proposed dry port is calculated in Appendix D.6.

7.5.2 Summary of Required Size Characteristics

The required size characteristics associated with the implementation of a dry port in the Western Cape supply chain can be summarized as follows (refer to section 7.5.1 and Table 21):

Table 21: Summary of Required Size Characteristics

Characteristic	Value
Throughput Capacity	700 000 TEU per annum
Primary Yard Area	467 766 m ²
Storage Slots	32 962 slots
Total Land Area	935 532 m ² (93.5ha)
Hinterland Capacity	45 moves/hour
CY Capacity Utilization	38%

The CY capacity utilization of the proposed dry port is just below average compared to that of the United States ports (refer to Figure 38), which suggests that the facility will have sufficient capacity to operate at the assumed 0.7 million TEU per annum.

7.6 Site Selection

The location of a dry port has great bearing on, and is influenced by, infrastructural efficiency. The location of a dry port will have a potential impact on regional as well as transport development. Therefore, one should take a holistic point of view when analyzing the potential location of a dry port (Yang, 2007).

The above statement led the researcher to do a review of available literature which focuses on site selection criteria of dry ports. From the reviewed literature it was clear that several site selection methods exist; however, most do not apply to the dry port concept. The researcher found that the site selection analysis presented by MariNova Consulting Ltd. (2006) was the most suited to the dry port concept, but did not sufficiently analyze the market demand aspects of the dry port concept. Therefore, the researcher recommends that the MariNova Consulting Ltd. (2006) site selection analysis be supplemented with the market demand section of the multi-criteria analysis presented by Smith (2010).

The site selection analysis was done by identifying several site characteristics, given in sections 7.6.2 to 7.6.10. The impact of these characteristics was analyzed to determine the viability of the dry port at that specific location, thus enabling the researcher to identify a possible optimum dry port location.

7.6.1 Possible Dry Port Locations

In the search for possible dry port locations the researcher reviewed a recent study done by Havenga et al. (2012), which had the purpose of determining possible locations for the development of an intermodal inland container terminal (dry port) in the greater Cape Town area. Havenga et al. (2012) performed a FEL (front end loading) 0 level multi-criteria analysis to identify possible suitable locations for the intermodal inland container terminal. A results summary of the multi-criteria analysis can be seen in Figure 47 below.

Criteria & KPI's		Locations										
		Land Area	Acacia Park	Atlantis area	Belville precinct	Culemborg precinct	Firgrove property	Kraaifontein area	Kraaifontein area	Kuilsrivier area	Salt River	Wingfield Naval Base
low-key design	166 ha (2016)	51	2 590	505	23	864	2X146	353	1 353	55	265	253
normal-key design	55 ha (2016)											
high-key design	25 ha (2016)											
low-key design	362 ha (2041)											
normal-key design	121 ha (2041)											
high-key design	56 ha (2041)											
Location Feasibility - Land Area		✘	✓	✓	✘	✓	✓	✓	✓	✘	✓	✓
Rail Efficacy												
Direct Line				Main Cape Town	Cape Town					TRE		
500m		Main (Cape Town)	Blouberg	Marshalling yard	Marshalling yard	Somerset West	Main (CapeCor)	Malmesbury	Stellenbosch		Main (Cape Town)	Side-line to port
Overhead												
Location Feasibility - Rail efficacy			✓	✓		✓	✓	✓	✓		✓	✓
Road Efficacy												
Free-way	1km											
Port (centre)	<20km											
Access	2 main road											
Location Feasibility - Road efficacy			✘	✓		✘	✘	✓	✘		✘	✓

Figure 47: Results Summary of Multi-Criteria Analysis (Havenga, et al., 2012)

The authors identified three possible locations for the development of such a facility, namely:

- a) **Kraaifontein Area:** a cluster of privately owned parcels of land located in the Kraaifontein region.
- b) **Ysterplaat Air Force Base:** a Government owned air force base located in the Milnerton region.
- c) **Bellville Precinct:** located on the same property as the Belcon facility, which is a Transnet Freight Rail facility located in the Bellville region.

The locations of these possible dry port sites are presented in Figure 48 below.

The three possible locations that were identified by the Havenga et al. (2012) study formed the base for the site selection analysis that was performed in section 7.6.11 of this study. It was assumed that the availability of these sites for the development of a dry port was taken into consideration in the Havenga et al. (2012) study.

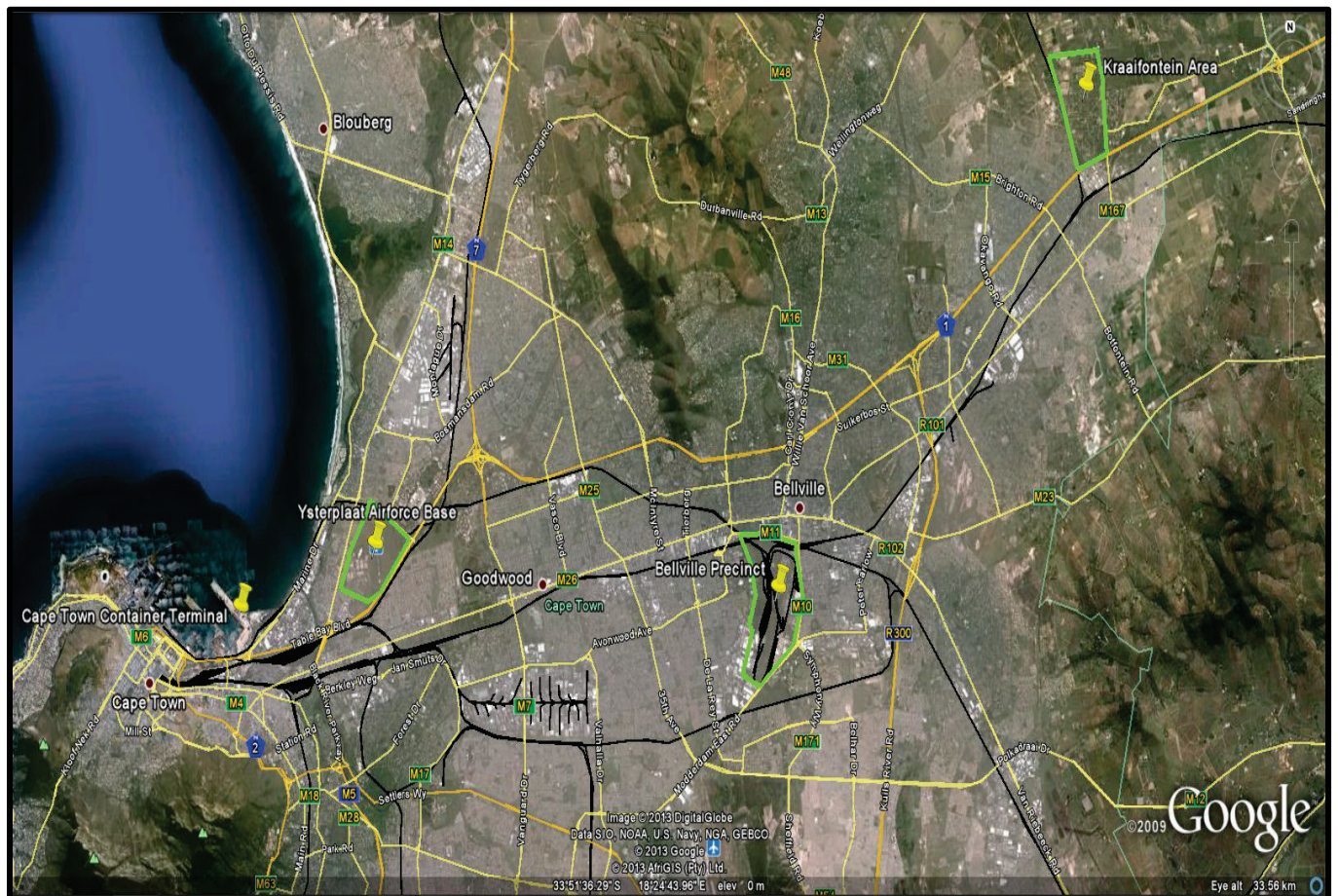


Figure 48: Possible Dry Port Locations

7.6.2 Property

The characteristics in this section of the analysis describe the physical features of the property and include key characteristics like size and shape, which are vital to the future expansion plans of a dry port. Furthermore, security and zoning of the property is also analysed in this section.

- a) **Bellville Precinct:** The current Belcon facility has a total area of 80 256m² (8ha) with a container terminal yard capacity of 60 reefer plug points and 5 900 container slots (based on 2-high container stacking). According to Richer (2010) the facility has the potential to be upgraded to 20 000 container slots with a throughput of about 0.3 million TEU per annum. This notion is supported by the fact that Belcon facility and City Deep facility (refer to section 2.6.3) have very similar available land areas and the City Deep facility achieved a throughput of just under 0.3 million TEU per annum in 2009. Furthermore, the presence of vacant land adjacent to the facility, which currently belongs to Transnet, could potentially enable the facility to increase its area to 505ha and thereby gaining the capacity to accommodate an annual throughput of more than 1 million TEU;
- b) **Kraaifontein Area:** The Kraaifontein area site consists of a cluster of privately owned parcels of land, which accumulate to a total area of 353ha. The parcels of land are currently zoned as residential, agricultural (smallholdings) and industrial;
- c) **Ysterplaat Air Force Base:** The Ysterplaat air force base is a Government owned air force base, which is situated on a 253ha parcel of land.

7.6.3 Acquisition

The characteristics in this section of the analysis describe the costs involved in acquiring a parcel or parcels of land. These costs include relative land value, estimated expropriation costs and assembly costs.

- a) **Bellville Precinct:** Transnet (the state-owned rail and port infrastructure owner and operator) owns the Bellville precinct land as well as the vacant land adjacent to the facility; therefore, no acquisition cost will have to be incurred. This should significantly reduce the required initial investment;
- b) **Kraaifontein Area and Ysterplaat Air Force Base:** The Kraaifontein area site and the Ysterplaat air force base are privately owned and government owned respectively. This will bring the complexity of buying land into the equation and would most probably result in a high required initial investment.

It should be noted that this study did not focus on the monetary value of these cost, but rather a holistic perspective of high, medium or low. It was assumed that this approach will shed sufficient light on the matter and that a detailed cost breakdown could be performed in future studies.

7.6.4 Environmental Condition of Site

The characteristics in this section of the analysis describe the environmental issues associated with the site, which include existing contamination, eco-sensitivity and land use impacts. Further to this, the biophysical and cultural resources of a site need to be identified and evaluated.

All three of these possible sites are environmentally neutral and the development thereof should not have any significant impact on the specific site or its surroundings. The Ysterplaat Air Force Base Museum is a cultural resource and will have to be relocated to a suitable location. The museum could possibly be relocated to either the Cape Town International Airport or the Langebaan Air Force Base.

7.6.5 Socio & Economic Impacts

The characteristics in this section of the analysis describe the compatibility of a site to be used as a dry port. These include the impact that the dry port will have on neighbouring areas and whether the local community will provide major opposition against the implementation of such a facility.

- a) **Bellville Precinct:** The Belcon freight rail terminal already operates on the Bellville Precinct site and presence of this terminal has the following positive impacts: Firstly, the core competency already exists at the facility and the concept of such a facility is already clear to the local community, which should reduce any local opposition as well as prevent any restrictions on operating hours. Secondly, the planners and developers are already familiar with requirements of such a facility;
- b) **Kraaifontein Area:** The Kraaifontein area site consists of a cluster of privately owned parcels of land of which the owners will have to be relocated to a suitable new location. The relocation might receive major local opposition and the local community will have to be engaged through the public participation process before this can be quantified;
- c) **Ysterplaat Air Force Base:** The Ysterplaat air force base has been in operation since the 1920's and still plays a significant role in the South African Air Force. The redevelopment

of this historical air force base might receive major local opposition and the perceived perspective of the local community will have to be investigated before this can be quantified.

All three the abovementioned facilities have the potential to provide the Port of Cape Town with the necessary CY capacity to accommodate medium term growth, as well as to promote intermodal transport in the region. Furthermore, these facilities also have the potential to enable the Port of Cape Town to optimize the use of the 'Cape Gateway' initiative (refer to section 7.2.3).

7.6.6 Topography

The characteristics in this section of the analysis describe whether or not a proposed site is suitable to accommodate railway infrastructure, have no natural physical impediment between the site and the maritime port as well as, the geotechnical acceptability of the site.

All three of these possible sites have the topographical characteristics to accommodate railway infrastructure and there is no natural physical impediments between these sites and the Port of Cape Town. The geotechnical acceptability of these sites is relatively unknown (no site specific geotechnical information is available); however, based on current land usage one, can assume that these sites should all be reasonably acceptable.

7.6.7 Access

The characteristics in this section of the analysis refer to the ease with which a desired destination may be reached, which includes accessibility to road and rail infrastructure.

- a) **Bellville Precinct:** The location of the Bellville Precinct enables it to access the three main freeways in the region, namely: the N1, the N2 (via R300) and the N7 (refer to Figure 49). The facility is located in a low traffic area and the access road, Modderdam Road, is currently operating below its design traffic load (refer to Figure 50). Furthermore, Modderdam Road has the potential to be upgraded to a three-lane carriageway, which could enable the facility to cope with the increased traffic loading that coincides with the development of a dry port. The Transnet owned Belcon freight rail facility, located within the Bellville Precinct, forms part of the 'Cape Gateway' initiative and has access to the national railway network (refer to Figure 49);

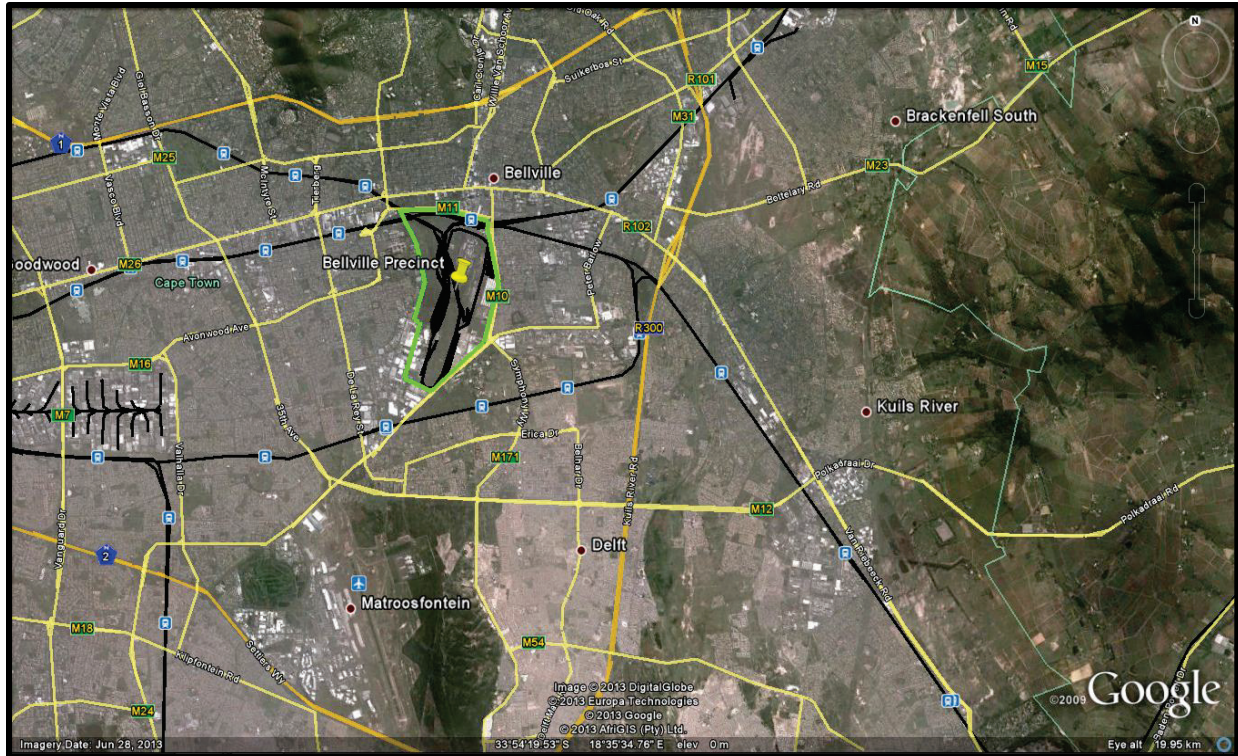


Figure 49: Regional Access to Bellville Precinct

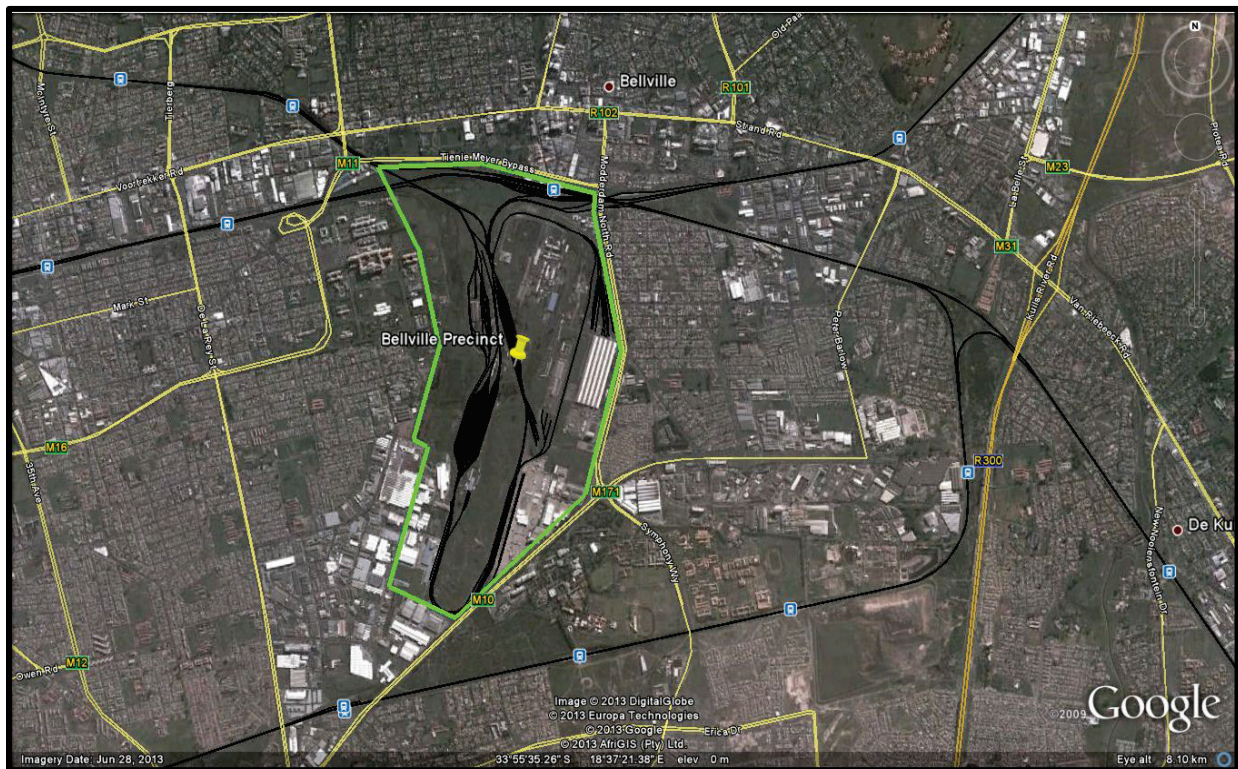


Figure 50: Local Access to Bellville Precinct

- b) **Kraaifontein Area:** The location of the Kraaifontein Area site enables it to have direct access to the N1 freeway and indirect access to the N2 (via R300) and N7 (via N1) freeways (refer to Figure 51). The facility could gain railway access via the Malmesbury railway line that runs on the western border of the site (refer to Figure 51);

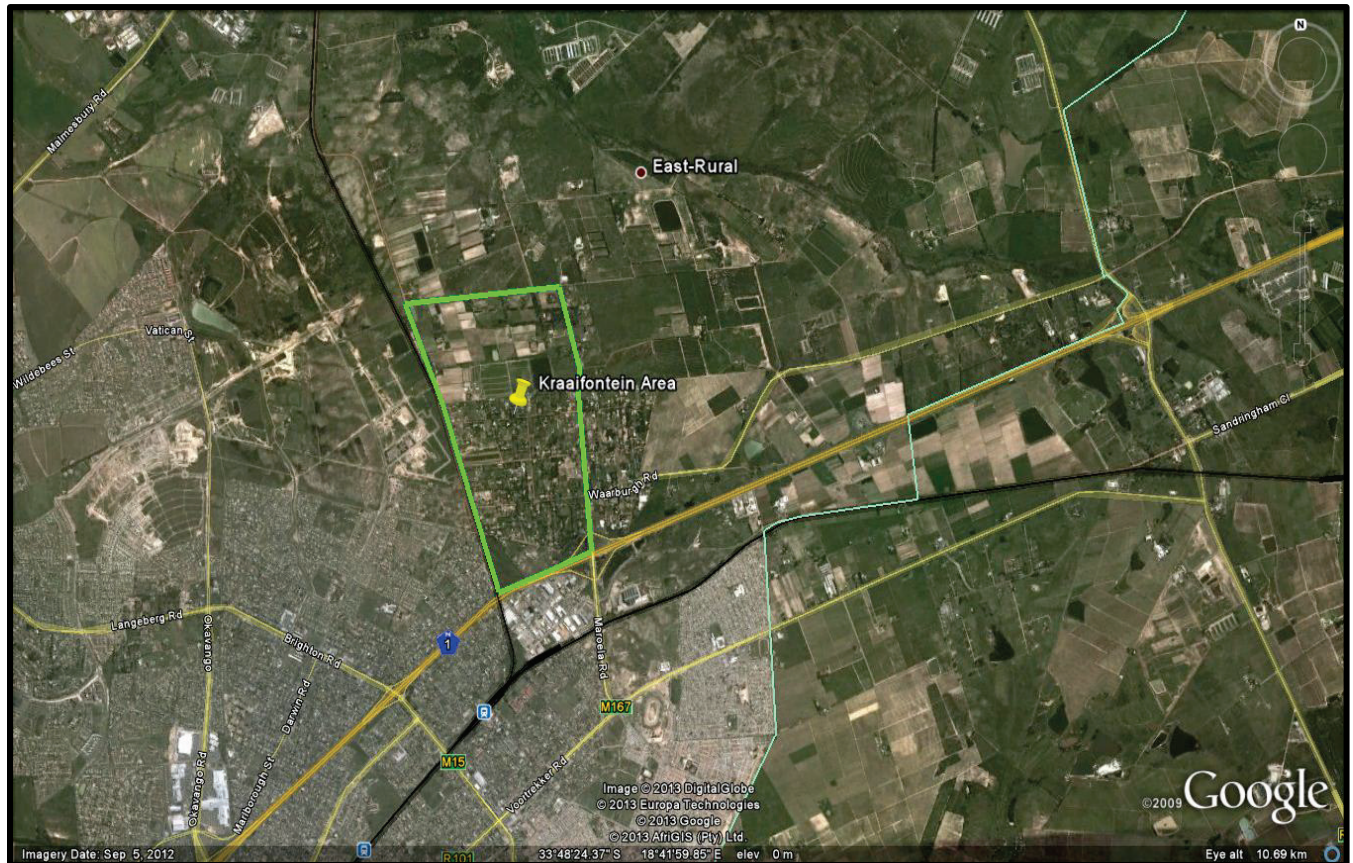


Figure 51: Local and Regional Access to Kraaifontein Area Site

- c) **Ysterplaat Air Force Base:** The location of the Ysterplaat air force base enables it to have direct access to the M5 and N1 freeways, with off-ramps located at each end of the facility, and indirect access to the N2 and N7 freeways, via the M5 and the N1 respectively (refer to Figure 52). The facility could gain railway access via the Cape Town Port feeder line that runs past Lagoon Beach and joins the main line near Acacia Park towards the Bellville railway precinct (refer to Figure 52).

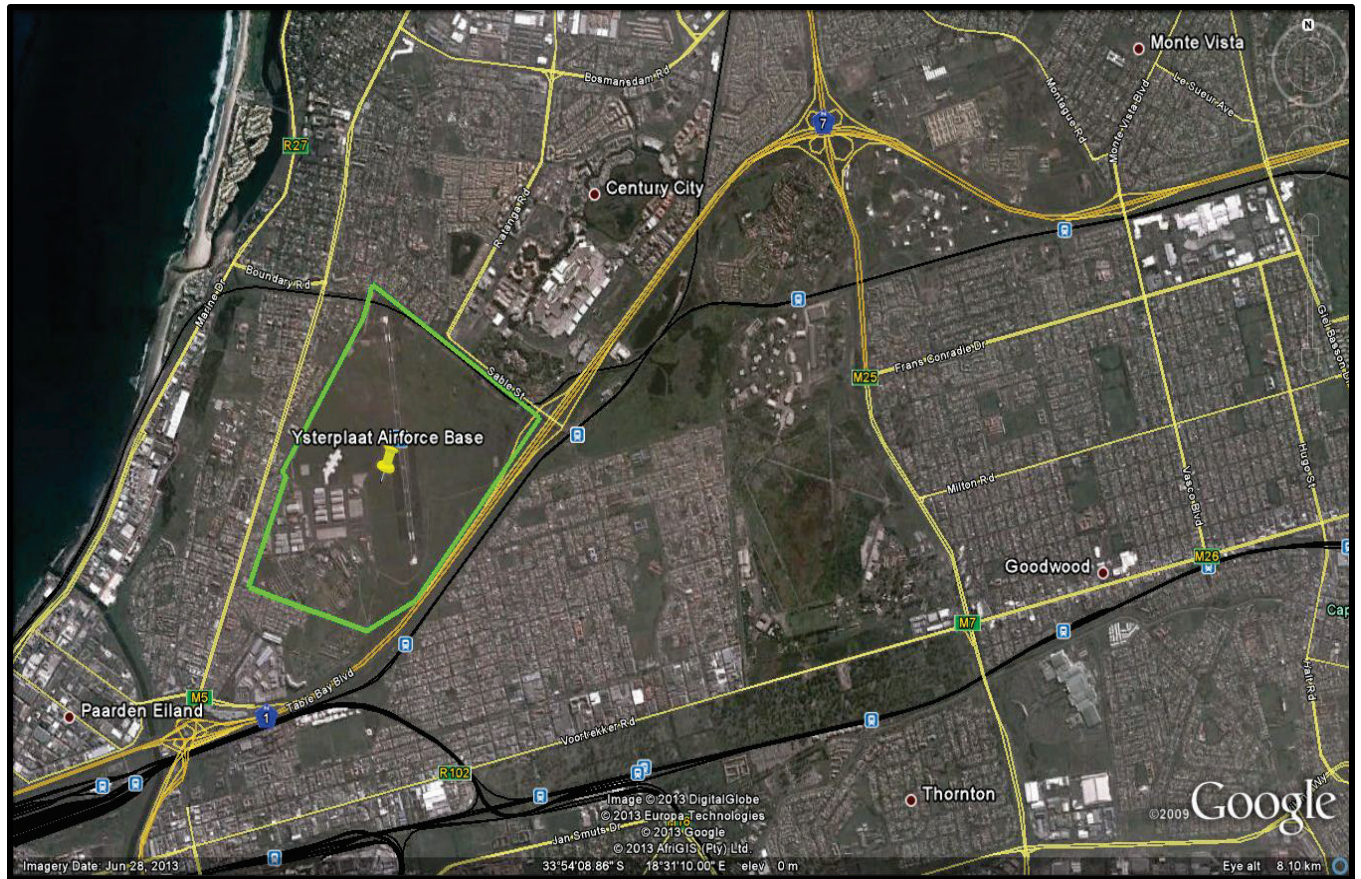


Figure 52: Local and Regional Access to Ysterplaat Air Force Base

7.6.8 Utilities

The characteristics in this section of the analysis refer to the availability of utilities at the proposed site. These utilities include communication/electrical, water, gas and sewerage.

- a) **Bellville Precinct & Ysterplaat Air Force Base:** The available utilities at both the Bellville Precinct and the Ysterplaat air force base should be sufficient to accommodate the development of a dry port, because both of these sites are currently accommodating facilities that require similar utilities.
- b) **Kraaifontein Area:** The underdeveloped Kraaifontein Area site does not currently have the utilities capacity to accommodate the development of a dry port and the cost associated with the development of these utilities will contribute to the required initial investment.

7.6.9 Location

The characteristics in this section of the analysis describe the location of the dry port in relation to the maritime port and the customer epicentre. MariNova Consulting Ltd. (2006) articulates the fact that this is one of the key elements of site selection, because the operating impact of a location may render a 'perfect' site unsuitable for the implementation of a dry port.

All of these sites are located in close proximity to the epicentre of the regional cargo catchment area and within the required 50km away from the Port of Cape Town (refer to section 7.2.4). These sites are ideally located to facilitate regional development and growth as well as the promotion of intermodal transports. Furthermore, the access to a direct railway line, between the site and the maritime port, significantly increases the feasibility of the development of a dry port at one of these sites.

7.6.10 Market Demand

According to Smith (2010) the ultimate success of a dry port is best measured by assessing its net economic contribution from both a private and public standpoint. The major categories of the market demand section of analysis include: Firstly, the main factor in the viability, location and size of a dry port is the volume of cargo going into and out of the region it serves (i.e. existing import and export shipments). In terms of economic development the volume or potential volume of export shipments play the biggest role. Smith (2010) states that the export of goods outside the local economy generates an inflow of capital to the local economy and thereby represents the sector most critical to regional economic vitality (i.e. the exporting industries serve to increase the living standard of the region). Although import shipment is a major role player, it is less important in improving the regional economy, and is given less weight in the evaluation.

Secondly, agriculture, mining, manufacturing and trade establishments are potential customers of a dry port due to its dependence on bulk shipments. These economic sectors form the financial bloodline for the dry port concept and lead to the ultimate success of such a facility. In the Western Cape these economic sectors are present in the form of the South African Fresh Fruit Industry (section 3.4.3), the South African Wine Industry (section 3.4.4) and the BMW Rosslyn initiative (section 3.4.5).

Lastly, forecasted population growth is linked to job growth, increased consumer purchases and additional economic development. These elements increase market demand for a dry port due to the increase in shipments going into and out of the region.

The market demand of the three possible sites can be described as follows:

a) Bellville Precinct:

Existing Import and Export Shipments: The current Belcon freight rail terminal already attracts sufficient cargo volumes to make the facility an attractive prospect for any planner or developer. The facility has the potential to have a significant positive impact on the regional economy, such as job creation (indirectly) and inflow of foreign capital.

Agriculture, Mining, Manufacturing and Trade Establishments: The site is located at the junction of all the major Western Cape agricultural feeder railway lines and it has a direct line to one of Cape Town's biggest trade and manufacturing regions (namely, Epping Industrial Area).

Population Forecast: The facility is located within the Northern Suburbs region, which is the suburban area with one of the highest population growth rates in the greater Cape Town metropolitan.

b) Kraaifontein Area:

Existing Import and Export Shipments: The current site is undeveloped and does not attract any noteworthy cargo volumes; however, the facility has the potential to become the region's economic pulse.

Agriculture, Mining, Manufacturing and Trade Establishments: The site is located at the junction of two Western Cape agricultural feeder railway lines, namely the Malmesbury and Paarl lines.

Population Forecast: Similar to the Bellville Precinct, the Kraaifontein Area site is also located within the growing Northern Suburbs region.

c) Ysterplaat Air Force Base:

Existing Import and Export Shipments: The current usage of the site does not attract any cargo volumes; however, the adjacent Montegue Gardens Industrial Area attracts a significant amount of cargo every year.

Agriculture, Mining, Manufacturing and Trade Establishments: The site is located adjacent to the Montegue Gardens Industrial Area and has access to the Wes Coast agricultural feeder railway line, which could both significantly improve the market demand of the facility.

Population Forecast: The facility is located in a region with very little residentially zoned land; however, the site has direct access to the west coast suburbs of Milnerton and Bloubergstrand. Both of these suburbs have shown a significant growth in population over the past couple of years.

7.6.11 Site Selection Results

A site selection analysis was done to determine the viability of developing a dry port at one of the three identified locations (refer to section 7.6.1), namely:

- Bellville Precinct;
- Kraaifontein Area Site;
- Ysterplaat Air Force Base.

The analysis was done by firstly, determining the site characteristics, identified in sections 7.6.2 to 7.6.10, of each of these locations (refer to Table 22) and secondly, to rate the impact of these characteristics on the development of a dry port. The site characteristics were rated by a neutral weighting analysis and a subjective weighting analysis. The results of the rated site characteristics are summarized in Table 23.

It should be noted that the weightings in the subjective weighting analysis were defined by the researcher and are based on the experience that were gained through the course of this study. Furthermore, the weightings were defined in line with the critical needs for the success of dry ports (refer to sections 2.7 and 7.3), with emphasis on required cargo volumes and initial investment costs.

Table 22: Results Summary of Site Characteristics

Site Characteristics	Locations			
	Requirement (2039)	Bellville Precinct	Kraaifontein Area	Ysterplaat Air Force Base
Property				
Size (ha)	>93.5ha	505	353	253
Minimum Width (m)	>300m	1 200	900	1 100
Minimum Length (m)	>1 500m	1 800	2 200	1 800
Expansion (ha) for Adjacent Development	>50ha	497	N.A.	N.A.
Zoning Non Residential	Yes	Yes	No – Smallholdings	Yes
Security Ranking (from 1 to 10)	>5	7	8	10
Major Structure Relocation Required	No	No	No	Marginal (could be relocated to Langebaan Air Force Base)
Major Demolition Required	No	No (just adjusting the layout)	No	No
Acquisition				
Land Value	N.A.	High	Low to Medium	High
Estimated Expropriate Cost	Low	Low (Transnet owned)	Medium to High	Medium (Government owned)
Assembly Costs	Low	Low (less than 5 parcels)	High (several parcels)	Medium (one parcel)
Environmental Condition of Site				
Contamination	Low	Low	Low	Low
Eco-sensitive	Low	Low	Low	Low
Biophysical and Cultural Resources	<Medium	Low	Low	Medium (Air Force Museum)
Socio/Economic				
Compatibility				
Neighbours (Type)	Non-Residential / Agricultural	Industrial / Non-Residential	Residential / Agricultural	Industrial / Non-Residential
Operating Hours Restrictions	No	No	No	No
Major Local Opposition	Low	Low	Medium to High	Medium to High
Likely Job Impact (creation)	>Medium	Medium	Medium to High	Medium
Planning Issues	Low	Low	Low	Low

Topography				
Railway Level	Yes	Yes	Yes	Yes
Natural Physical Impediments	None	None	None	None
Geotechnical acceptable (Preliminary)	Yes	Yes	Yes	Yes
Access				
Trucking				
New Freeway Interchange Required	No	No	No	No
Local Access Road Reasonable	Yes	Yes	Yes	Yes
Proximity of Freeway	<1km	Marginal	Yes	Yes
Rail				
Major Structures Required	No	Yes	Yes	Yes
Proximity of Railway	<500m	Yes - Marshalling yard	Yes - Malmesbury Line	Yes - Cape Town Port feeder line
Utilities				
Communication/Electrical	Yes	Yes	No	Yes
Water/Gas/Sewer	Yes	Yes	No	Yes
Location				
Trucking Partners				
Distance to Customer Epicentre (km)	<50km	Yes	Yes	Yes
Railway				
Distance to Maritime Port (km)	<50km	Yes	Yes	Yes
Direct Line	Yes	Yes - Main Line	Marginal	Yes - Cape Town Port feeder line
Overhead Electrical Lines	Yes	Yes	No	No
Market Demand				
Import Shipment Volumes	>Medium	Medium to High	Low	Medium
Export Shipment Volumes	>Medium	Medium to High	Low	Medium
Potential customers (Agriculture, mining, manufacturing and trade establishments)	>Medium	High	Medium	Medium to High
Population Growth	>Medium	High	High	Medium

Table 23: Results Summary - Site Selection Analysis

Site Selection Analysis	Locations		
	Bellville Precinct	Kraaifontein Area	Ysterplaat Air Force Base
Neutral Weighting (refer to Appendix E.1)	97.3%	86.5%	92.8%
Subjective Weighting (refer to Appendix E.2)	97.0%	85.3%	92.2%
Ranking	1	3	2

The results of the site selection analysis, shown in Table 22 and Table 23, can be interpreted as follows: Firstly, all three the sites that were analysed have the potential to be developed into a successful dry port. The analysis showed that none of the site characteristics would leave these sites completely undevelopable.

Secondly, the Kraaifontein Area site is the least favourable amongst the three analysed sites, due to the underdeveloped condition of the existing site as well as the relatively high acquisition cost.

Lastly, both the Bellville Precinct and the Ysterplaat air force base provide persuasive arguments for the development of a dry port. The position of the Ysterplaat air force base is, however, negatively influenced by the possibility of strong local opposition and the relatively high acquisition cost.

Based on the abovementioned interpretation, the researcher found that the Bellville Precinct would be the most viable site to develop into a dry port. This notion is further supported by the presence of the Belcon freight rail facility, which provides a compelling argument for the development of the Bellville Precinct into a dry port, namely:

- The facility is a Transnet Freight Rail facility, which is, therefore, operated and owned by Transnet;
- The facility forms part of the 'Cape Gateway' initiative and has access to the national railway network;

- The facility already operates a daily small scale rail shuttle to and from the Port of Cape Town, thus supporting the notion that the planners and developers are already familiar with the requirements of such a facility;
- The core competency required to successfully develop and operate a dry port already exists at the Belcon facility.

7.7 Implementation of a Dry Port in the Western Cape Supply Chain

Section 7.6 identified that the Bellville Precinct would be the most viable site for the development of a dry port; however, it should be noted that without a proper implementation strategy the facility will not be able to come to a realisation. The following section briefly describes a possible implementation strategy that could be applied for the implementation of a dry port in the Western Cape Supply Chain.

7.7.1 Phased Development Model

The availability of resources for the initial investment of a dry port is one of the most important critical needs for the successful implementation of a dry port. By adopting a phased development approach the resources needed for the initial investment can be kept to a minimum.

A phased development plan is needed because it is unrealistic to expect that all current activity could be relocated, to the newly developed dry port, within the short term. Existing facilities represent a major investment and cannot suddenly be abandoned. However, over time the advantages of a dry port will provide the incentives for growth at the new location.

The purpose of this section is to outline a phased approach for the implementation of a dry port. A three-phased approach is recommended by Smith (2010) and the author suggests that each phase should increase in complexity and facility requirements.

- **Phase 1 – Regional Logistics Organization or Alliance:** Smith (2010) recommends that the first phase in the development of a dry port entails a forum that facilitates the identification of transportation and logistics issues in the region as well as the rectification thereof. The establishment of such a forum can be accomplished at relatively low cost through the establishment of a logistics organization, which can initially identify and deal with specific issues. The purpose of the organization is to assist regional shippers and service providers in developing cost effective logistics solutions through the interaction of

the organization's members. Furthermore, the function of the organization is to identify and justify the physical facilities needed in phase 2. Evidence of such a development is already present in the Western Cape with the launch of the Wesgro free trade portal (refer to section 3.4.1). Furthermore, the existence of Transnet as a complete operating company (owner and operator of the maritime port, railway lines and possibly the dry port) could further facilitate the development of such an organization or alliance.

- **Phase 2 – Freight Consolidation Facilities:** Smith (2010) goes on to recommend that once the regional logistics organization has matured and developed a support base of shippers and service providers, it can begin considering other initiatives, which require operational facilities. The author identifies that one type of inland facility that may be considered is a freight consolidation facility, which can be used to consolidate small shipments into rail cars or full container loads to reduce drayage costs. The Belcon freight rail facility is a prime example of a facility in the Western Cape supply chain that could be adapted to form the backbone for phase 2 of the implementation strategy. The Belcon facility already possesses the core competency required to successfully develop and operate such a facility.
- **Phase 3 – A Dry Port:** Finally, Smith (2010) recommends the development of a fully functional dry port. The author states that, although it is generally difficult to justify the start-up of a new dry port and supporting intermodal service, it is possible as long as there is enough volume and a reasonable business case. The key critical needs for the successful development of a dry port in the Western Cape supply chain were identified in section 7.3. The development of the Bellville Precinct will have to adhere to these needs to ensure the success of the project.

From the above it is clear that the foundation for phase 1 and 2 of the implementation strategy already exists in the Western Cape supply chain. These phases could easily become a realisation through careful planning and collaboration of all the relevant stakeholders.

The productivity of the proposed dry port will also be a key factor in the overall success of the facility. Therefore, the fully functional dry port would have to provide several value-added services of which some are discussed in section 7.7.3.

A brief description of the required upgrading of the Belcon Precinct, during phase 2 and 3 of the implementation, is given in section 7.7.4.

7.7.2 Classification of Proposed Dry Port

The implementation of a phased development model implies that the classification of the proposed dry port would not remain constant during the development, but would rather evolve along with the facility. The classification would evolve as follows: Firstly, the proposed dry port (phase 2) would most likely start as a facility that can be classified as a Close-Satellite Marine Terminal, with the primary function of providing a consolidation or deconsolidation point for goods being shipped in or out of a congested maritime port (refer to section 2.4).

Secondly, the aim of the proposed dry port (phase 3) would most likely be to develop into a Close-Integrated Logistics Park with integrated operations encompassing both import and export functions along with container storage (refer to section 2.4).

7.7.3 Services Provided at Proposed Dry Port

The proposed dry port could possibly provide the following specialized services to its customers:

- **Longer Stack Dates:** The presence of a dry port in the supply chain could allow for longer stack dates, which provide the manufactures with more flexibility in their production chain. The longer stack dates could also enable shipping lines to plan their operations more efficiently and avoid overbooking; however, this implies that clear communication exists between all the role players in the supply chain.
- **International Port Services:** The dry port has the opportunity to be granted the status of bonded territory, which would enable the facility to assist the maritime port with all customs related procedures. These procedures could include transit declarations, customs duties and quarantine and inspection services. Granting the dry port the status of bonded territory can also increase the efficiency of the shuttle system and avoid any unnecessary delays at the maritime port.
- **Empty Container Supply:** The movement of empty containers plays a major role in the transportation network and therefore, if the need for empty movements can be reduced or rationalized, total system cost can be reduced. The dry port provides the transportation network with the opportunity to reposition empties, through the use of the rail shuttle, thereby enabling the re-using of imported empties for export loads.

7.7.4 Upgrading the Proposed Dry Port Site

The development of the Bellville Precinct into a dry port will involve amongst other things the upgrade of the CY capacity and the shuttle system.

The CY capacity will have to be increase from 5 900 container storage slots to 32 926 container storage slots (refer to section 7.5.2). In order to accommodate the estimated throughput the facility would have to undergo a complete reconfiguration and the upgrading of the current surface to be able to accommodate RTG cranes and other heavy handling equipment.

The railway connection between the Bellville Precinct and the Cape Town Container Terminal will have to be upgraded with the latest equipment and technology. This will ensure that the shuttle system operates at maximum efficiency. A possible upgrade solution will be to use double stack wagons, which makes the shuttle system more feasible and efficient by loading twice as many containers with the same number of trains (refer to Figure 53). It should be noted that such a system requires a 6m clearance between the rail and the electrical wiring, bridges or tunnels, which might not be possible.



Figure 53: Double Stacked Rail Wagons

Chapter 8 Increasing Quay Capacity in Port of Cape Town

8.1 Introduction

The implementation of a Dry Port facility in the Western Cape supply chain would ensure that the CY area of the Cape Town Container Terminal is no longer the capacity limiting characteristic in the terminal, but rather the container berth capacity. The Port of Cape Town would, therefore, be required to find innovative ways to increase the ports container berth capacity.

This section of the study briefly focuses on a couple of systems that could be used to increase the container berth capacity of the Port of Cape Town. Firstly, the section describes the traditional system of seaward expansion (reclamation) and secondly, it briefly looks at slightly less conventional systems, namely float container cranes, slip berths and FastNet.

8.2 Seaward Expansion (Reclamation)

Historically the Port of Cape Town has always made use of seaward expansion to increase its size and capacity (refer to section 4.2). The most recent seaward expansion was the construction and reclamation of the Ben Schoeman Dock in the 1970's (refer to Figure 54). The project included the following aspects:

- the construction of the outer sea wall, which consisted of a revetment in the south and a combination of concrete caissons and block walls in the north;
- the construction of the inner quay wall, which consisted of concrete block walls;
- the reclamation of the quay area, between the outer sea wall and the inner quay wall. The reclamation was done through the use of dredged material within the basin as well as quarried sand, which was hydraulically pumped from a sand quarry in the Milnerton area (similar to the sand bypass system currently in place at the Port of Durban).



Figure 54: Reclamation of Ben Schoeman Dock (Winterbach, 2012)

From the above it is clear that the most familiar and commonly used expansion technique in the Port of Cape Town is seaward expansion and, therefore, it is no surprise that this option currently forms the base for Transnet's future expansion plans.

- **Short Term Layout (present to 2019):** the full commissioning of Cape Town Container Terminal Expansion Project Phase 2;
- **Medium Term Layout (2019 to 2042):** seaward expansion of Cape Town Container Terminal to balance container yard and berth capacity (refer to label 1 of Figure 55);
- **Long Term Layout (beyond 2042):** new breakwater (refer to label 1 of Figure 56), new outer basin with deepwater berths (refer to label 2 of Figure 56) and reclamation to increase the CY capacity (refer to label 3 of Figure 56).



Figure 55: Medium Term Layout – 2019 to 2042 (Ruthenavelu, 2011)

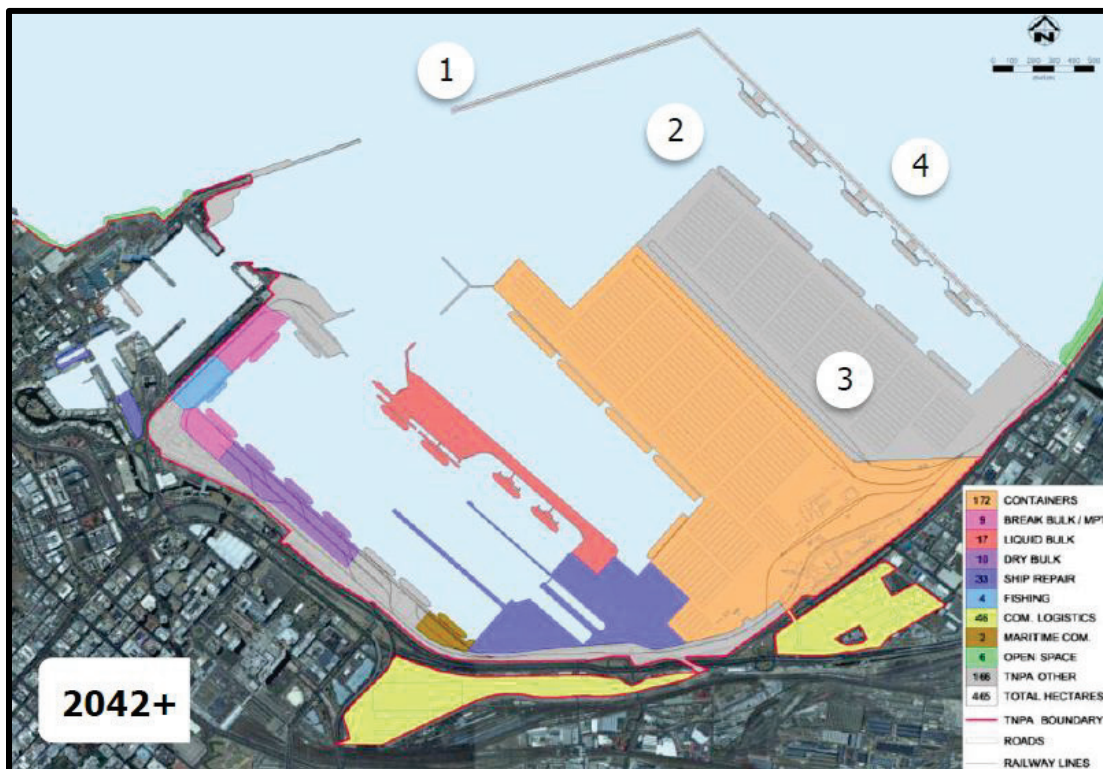


Figure 56: Long Term Layout – Beyond 2042 (Ruthenavelu, 2011)

The Cape Town Container Terminal could be expanded by using the seaward expansion option; however, one should note the following potential hurdles when considering this option:

Firstly, the world market is currently placing more and more emphasis on the holistic impact of any project, which requires projects to significantly reduce their carbon footprint as well as their impact on the eco-system. The holistic approach will place the construction techniques and materials (for quay and reclamation) under severe scrutiny and the project will have to convince the local community that it will have no significant impact on the coastal processes within Table Bay.

Secondly, the required initial investment is significant and the return on investment takes several years to come to a realisation.

8.3 Floating Container Crane Concept

The concept of the floating container crane is fairly simple and based on existing technology that is applied in an innovative way. The system enables container berths to increase their capacity without increasing their quay length, through the implementation of additional STS gantry cranes, fastened to a pair of pontoons (refer to Figure 57).

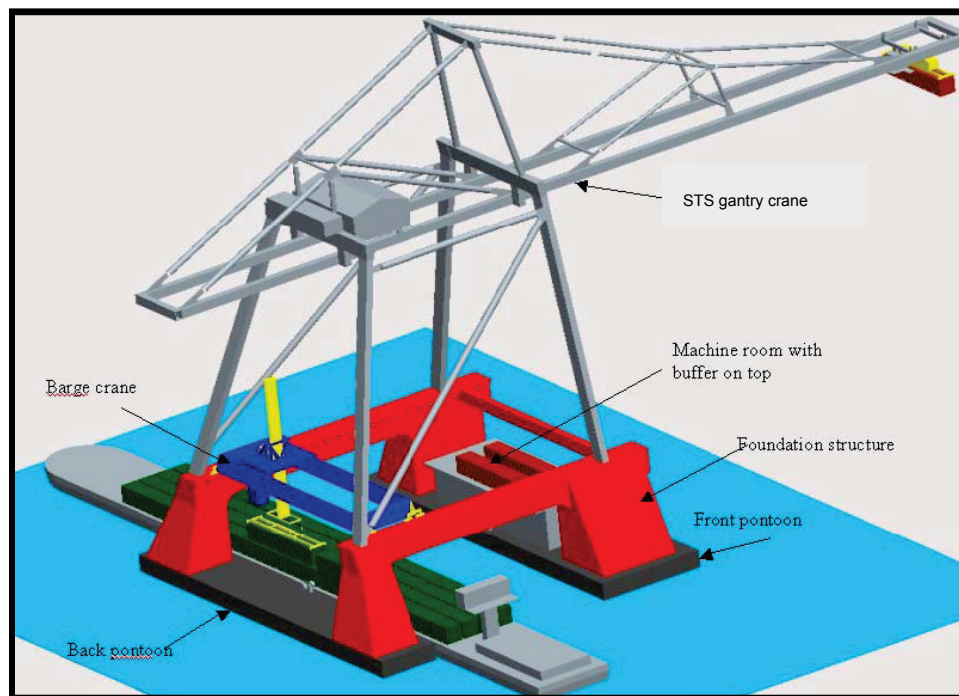


Figure 57: Floating Container Crane (Pielage, et al., 2008)

The concept arises from the fact that the number of quay cranes that can simultaneously work on a vessel is limited by their base dimensions. The spacing leaves the floating crane with the opportunity to increase the berth capacity by working on the bay that is located between the adjacent quay side cranes (refer to Figure 58).

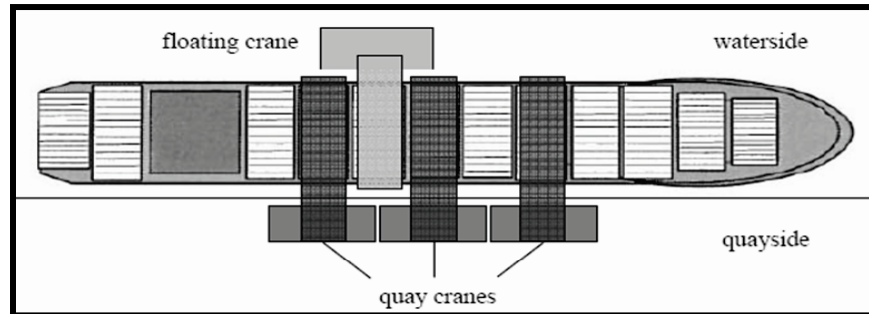


Figure 58: Crane Positions During Loading or Unloading (Pielage, et al., 2008)

Ligteringen et al. (2004) established that the implementation of floating container cranes could increase the productivity of the container berth without influencing the shore-side operations. The Ligteringen et al. (2004) research project led to a study that was done by Pielage et al. (2008), which focused on the feasibility of the floating crane concept.

Pielage et al. (2008) identified European container terminals where the floating crane concept could possibly be implemented. The authors assessed possible locations by implementing five different operational case studies at the terminals, namely:

1. *"Floating cranes handle only those containers that are known to continue by barge, without changing vessel stowage planning."*
2. *"Floating cranes handle all containers in the bay it is working on, the barges remain at the terminal and the containers are (second) handled back onto the terminal by the quay (barge) crane."*
3. *"Floating cranes handle all containers in the bay it is working on; the barges transport all the containers to the Barge hub terminal, where all containers are (second) handled."*
4. *"Floating cranes handle all containers in the bay it is working on, the transshipment containers are put into one barge which remains at the terminal and are second handled similar to Case 2, and all other containers are transported by barge to the barge hub terminal and second handled similar to Case 3."*
5. *"Floating cranes handle only barge containers which have been grouped by the vessel stowage planners to allow for an efficient handling by floating cranes (change in vessel stowage planning required)."*

The Cape Town Container Terminal has the required characteristics to accommodate the floating crane concept based on the fact that the Ben Schoeman Dock is wider than the required

305m (Pielage, et al., 2008) to allow safe operation of the floating cranes. The concept would have to operate on a similar base than Case Study 2 (refer to list above). The floating crane would handle all the containers in the bay that it's working on. The transport barges would remain at the terminal, where the containers are loaded onto the quay, through the use of quay side barge crane. The operation would take place at berths 500 to 502 on the southeast quay of the Ben Schoeman Dock.

The system would, therefore, increase the container berth capacity, by reducing the vessel turnaround time; however, at an increased cost. The increased cost is due to the double handling of the containers that are served by the floating crane system. These costs could be offset by the fact that the floating crane is highly versatile (can be used in both the Ben Schoeman and Duncan Docks) and would be able to assist in diverting investment cost associated with expanding quay infrastructure.

In assessing the feasibility of the floating crane system at the Cape Town Container Terminal one should note that the system has the following operational implications:

- The floating container cranes take around 30 minutes longer to commence operation than the quay side cranes;
- The floating container cranes can only operate at about 80 to 90% of the productivity of its quay side crane counterparts;
- The floating crane will require the implementation of operational restriction to avoid container spreader collisions;
- The total investment costs of the floating crane are estimated to be around 18 million Euro (Pielage, et al., 2008), excluding the transport barges and the investment at the barge berths.

8.4 Slip Berth Concept

The concept of the slip berth is not a new idea; however, due to the operational complexity of such a system its feasibility has been debated since the start of the STS gantry crane era. The system enables container berths to serve ships from both sides and allows as many as nine cranes to simultaneously operate on a single ship (refer to Figure 59).



Figure 59: Slip Berth Concept (Bhimani & Hsieh, 2001)

The first slip berth in the world was implemented at the Ceres Paragon Terminal in Amsterdam and the system incorporated several special features into the normal quay side crane system, namely: Collision Avoidance Systems, Semi-Automatic Operation and Crane Passing System (refer to Figure 60).

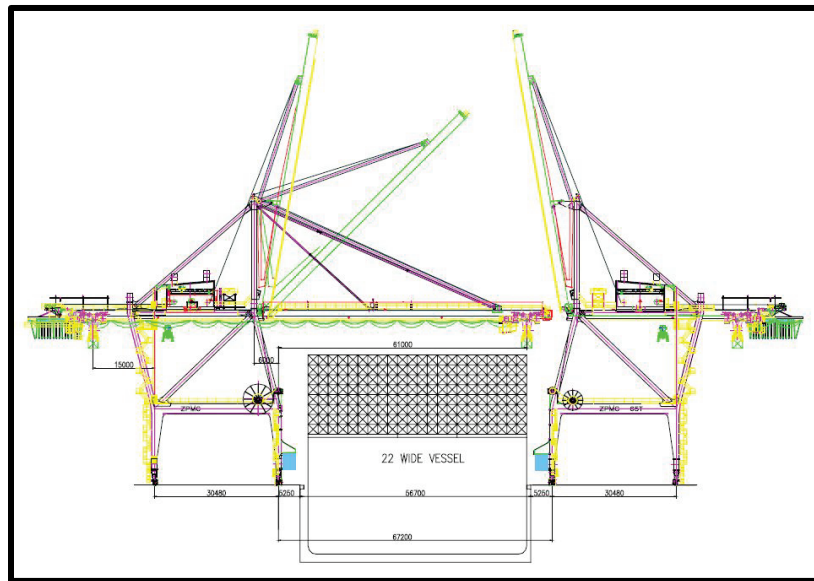


Figure 60: STS Gantry Cranes at Slip Berth (Bhimani & Hsieh, 2001)

The Cape Town Container Terminal has the required characteristics to accommodate a slip berth at the south-eastern end of the Ben Schoeman Dock, currently berths 500, 501 and 502. The greatest advantage of implementing this system in the Port of Cape Town would be that the container berth capacity can be increased without expanding the port further into Table Bay.

In assessing the feasibility of the slip berth system at the Cape Town Container Terminal one should note that the system has the following operational implications:

- The slip berth would significantly alter the layout of the Ben Schoeman Dock and the effect thereof on the following processes should be investigated:
 - The siltation of the basin
 - The effect of long period waves within both the basin as well as the slip berth
 - The slip berth could possibly influence the available berth length at the north-eastern end of the Ben Schoeman Dock, currently berths 600 to 604.
- The slip berth significantly influences the complexity of vessel manoeuvring within a basin.
- The total investment costs would be relatively high due to the construction of additional quay infrastructure.

8.5 FastNet Concept

The traditional STS gantry cranes have a leg width of 27m (buffer-to-buffer), which prevents the cranes from working on adjacent ship bays (as explained in section 8.3).

The FastNet concept has been developed by AP Moeller Terminals and this innovative crane technology has the potential to effectively double container berth productivity (450 moves/hours) by enabling cranes to work on adjacent ship bays (World Cargo News, 2010).

The FastNet concept consists of two large horizontal girders, which are raised 50m above wharf level and supported by intermediate frames. The cranes are suspended on these girders, which enable the system to operate without the traditional portal frames. As a result, the cranes are as narrow as a 40ft container and can work adjacent ship bays.

The increased number of cranes and the resulting high productivity required these cranes to have a large rail gauge of 55m, which can accommodate 12 vehicle lanes under the cranes. The enlarged rail gauge ensures that the system can cope with the high volumes and alleviates quay-primary yard transfer congestion (World Cargo News, 2011).

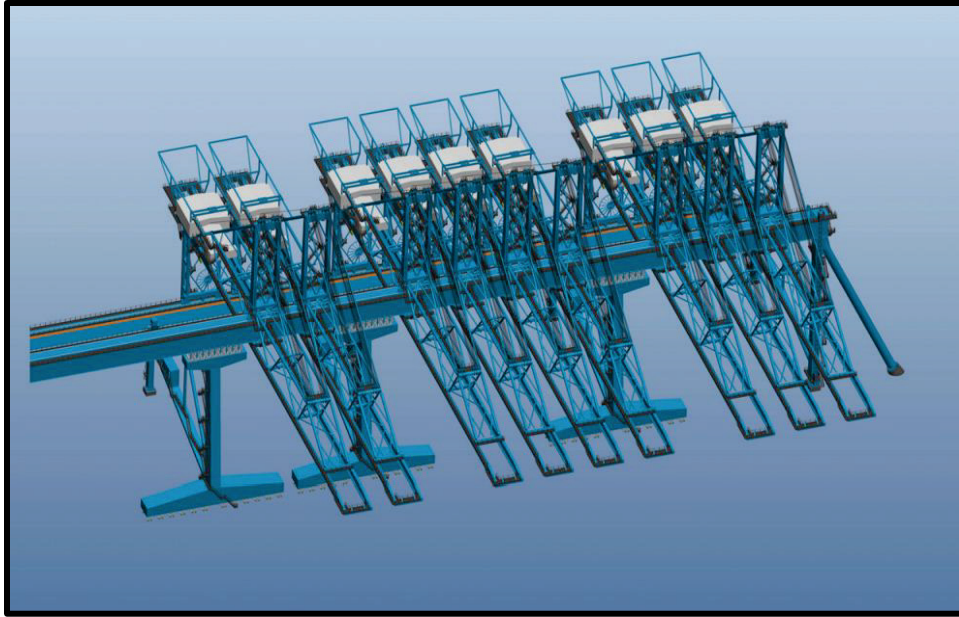


Figure 61: FastNet Concept (World Cargo News, 2011)

The FastNet system is designed to keep the structural loading on the quay to similar levels than that of the traditional STS gantry cranes; therefore, the Fastnet system could be commissioned at the Cape Town Container Terminal. The system would increase the container berth capacity of the terminal by allowing more cranes to simultaneously service the berthed ships. Similar to that of the floating container crane and slip berth concepts the FastNet system would allow the Port of Cape Town to increase the container berth capacity without requiring land reclamation into Table Bay.

In assessing the feasibility of the FastNet system at the Cape Town Container Terminal one should note that the system has the following operational implications:

- The FastNet system requires a large rail gauge, of 50m and more, to accommodate the increases cargo volumes. The increased rail gauge would require a reconfiguration of the terminal;
- The high volumes would require an upgrade in CY equipment to prevent congestion between the quay and the primary yard.

Chapter 9 Summary and Conclusion

9.1 Factors Supporting the Implementation of a Dry Port

The dry port concept includes the notion that some of the facilities at traditional maritime ports could be duplicated or complemented at inland locations, thereby promoting economic development and logistics integration as well as reducing the demand on limited capacity (land and access) at the maritime port. The notion is supported by the definition of a dry port, defined in section 2.3.1:

A dry port is an intermodal container terminal at a site displaced from maritime ports (outside the maritime port boundary) where transportation, warehousing and stacking capabilities, combined with value-added services, can facilitate and promote international trade, relieve maritime port congestion and enhance local, regional and national economic and social developments. Dry ports function in a similar manner to that of maritime ports and can be considered as an extension of the maritime ports. Dry ports are mostly container-oriented with a direct connection via rail and/or road to one or more maritime ports.

The implementation of the dry port concept within the Western Cape transportation network would therefore be appealing to the following stakeholders:

- TNPA and TPT;
- Shippers and Logistics Managers;
- Western Cape Regional Community.

The following factors support the implementation of a dry port as an integral part of the Port of Cape Town's transportation network.

9.1.1 Port Congestion

The worldwide economic growth and increasing flow volumes of goods are creating challenges for all maritime ports, in terms of lack of capacity or efficiency. A survey done by Trainaviante (2009) concluded that maritime ports are not expanding quickly enough to be able to cope with the ever growing demand, thus resulting in facilities that suffer from chronic congestion problems.

The abovementioned increase in volumes as well as the resulting congestion is also present at the Port of Cape Town. Firstly, the container cargo volume forecast which was done in section 4.4.2 predicted possible future container volumes for the Port of Cape Town, with an upper limit of 5% growth and a lower limit of 3% growth (year on year average). The predicted future container volumes show that the demand in the Port of Cape Town could reach between 1.9 million and 3.2 million TEU per annum by 2039. Factors that are driving the increase in container cargo volumes at the Port of Cape Town are among other things:

- The Port of Cape Town is the first and last port of call on the North / South container line routes and can offer a time saving for cargo moving between Cape Town and Gauteng. The opportunity is currently being utilized by BMW (refer to section 3.4.5);
- The fruit export market has shown a significant migration from break-bulk transportation to containerized transportation (refer to section 3.4.3).

Secondly, the evaluation of the operational and infrastructural characteristics of the existing Cape Town Container Terminal that was done in Chapter 5, demonstrated that congestion is present in the Cape Town Container Terminal and that the CY area is the capacity limiting characteristic of the terminal. Furthermore, it is estimated that the operational and infrastructural limits of the existing Cape Town Container Terminal could be reached in 2020 (5% growth) or 2026 (3% growth), under the current port operational layout, and in 2018 (5% growth) or 2021 (3% growth), under possible new port operational layout (refer to section 5.4).

9.1.2 Road Congestion

The world-wide success of road transportation has resulted in an imbalance in transport modes, which has created primary impacts such as road congestion and environmental problem, and secondary impact such as loss of time, additional vehicle maintenance cost, indirect health effects and stress.

The abovementioned imbalance is also present in the South African transportation system due to the deregulation of road freight transport in terms of the Transport Deregulation Act, 1988 (Act 80 of 1988), which had the vision to increase economic efficiency by creating a competitive South African transportation market. The result was, however, that the growth and success of road transportation overshadowed rail transportation and currently carry carries the majority of the market share.

Furthermore, nearly all South African maritime ports, including the Port of Cape Town, lack multiple access points, which contribute to the inefficiencies in the industry. The root of the problem lies with the historic development of Cape Town and the fact that the growth of the city has been directly related to the growth of the port. This resulted in the Port of Cape Town being surrounded by infrastructure that have not been nor could have been planned and build to accommodate the current freight- as well as commuter traffic growth rates.

Therefore, by addressing the problem of road congestion in and around the greater Cape Town metropolitan, the improved transportation network will have a positive effect on passenger traffic, productivity of trucks, competitiveness of the Port of Cape Town as well as the environmental sustainability of the transportation system.

9.1.3 Environmental Problems

Although environmental problems are not the focus of this study it is undeniable that the presence of the congestion problems in both the maritime port and the road network has an adverse effect on the environment, namely: global warming, greenhouse gasses, altering of hydrological processes and interfering with ecological systems (refer to section 2.5.3).

9.2 Critical Needs for the Success of a Dry Port

The presence of the following critical needs support the implementation of a dry port as an integral part of the Port of Cape Town's transportation network.

9.2.1 Volume

For a dry port to be viable it needs to be located in a cargo catchment area that generates sufficient demand to be able to create the economies of scale needed for cost effective operations. Therefore, the two main functions of a dry port facility in the Western Cape transportation network would be international trade processing and congestion relief, which are achieved through the duplication and supplementation of the Cape Town Container Terminal facilities at an inland location. It should be noted that the dry port would not double nor replace the capacity of the Cape Town Container Terminal, but would rather act as a supplementary node in the supply chain that strengthens the position of the Port of Cape Town.

The dry port would allow the Western Cape supply chain to absorb any future container volume demands that exceed the CY capacity of the Port of Cape Town. Section 7.4 identified that a dry port in the Western Cape could potentially attract an annual throughput of 0.7 million TEU by

2039, which is significantly more than the required 20 000TEU per annum needed to be profitable.

9.2.2 Seasonality

Although the effects of seasonality on the supply chain were not the focus of this study, it should be noted that in the Western Cape region a significant portion of the market consists of agricultural and horticultural products and effect thereof on profitability would have to be offset by attracting complementary cargo volumes in the offseason. These complementary cargo volumes would ensure that the dry port remains economically viable throughout the year.

9.2.3 Synergy

The successful implementation of a dry port in the Western Cape transportation network will rely on the presence of synergy between all the relevant role players, of which Transnet is the biggest. Transnet would, therefore, have to lead by example and facilitate the process within the transportation network.

9.2.4 Distance, Location and Access to Transportation Infrastructure

For a dry port to be viable it needs to be located in an area that adheres to the following requirements: firstly, the location needs to have sufficient land area to accommodate future container volumes as well as the development of regional distribution centres. The size requirements of a dry port in the Western Cape transportation network were determined in section 7.5 and determined that the parcel of land needs to have a minimum area of 935 532 m², with a CY area of 467 766 m².

Secondly, the location needs to be in the epicentre of the market catchment area to be able to attract the required container cargo volumes; therefore, the successful implementation of a dry port in the Western Cape will depend on the ability of the facility to provide the nearly 3 million consumers in the region with a reliable and efficient service.

Thirdly, the location needs to be a sufficient distance away from the maritime port for rail transportation to be able to compete with road transportation, thus the implementation of a dry port in the Western Cape supply chain will only be viable if the dry port is located within the greater Cape Town area, outside the City of Cape Town's central business district.

Lastly, the location needs to have sufficient access to multimodal transportation infrastructure; therefore, the dry port would have to be located in close proximity to the N1 and N2 national freeways as well as the Cape-Gauteng railway corridor.

The site selection analysis performed in section 7.6 incorporated the abovementioned requirements to analyse three possible dry port locations, namely:

- Kraaifontein Area Site;
- Ysterplaat Air Force Base;
- Bellville Precinct.

The site selection analysis identified that all three of the sites have the potential to be developed into a successful dry port; however, that the Bellville Precinct is the preferred location due to the presence of the Belcon freight rail facility, which provides a compelling argument for the development of the Bellville Precinct into a dry port.

9.2.5 Initial Investment

The availability of resources for the initial investment of a dry port is one of the most important critical needs for the successful implementation of a dry port project. To ensure that the resources needed for the initial investment is kept to a minimum one needs to adopt an implementation strategy that is based on a phased development approach.

The presence of Transnet enables the Western Cape region to be well positioned to implement a dry port through the use of such an implementation strategy, thereby providing a flexible dry port solution that will be able to adapt to the ever-evolving market. Furthermore, the development of a Brownfield site will be the most feasible for the development of a dry port in the Western Cape region due to the fact that it being a relatively new concept in Africa.

Based on the above it can be concluded that the most viable dry port solution in the Western Cape region would be the phased development of Bellville Precinct. The implementation strategy would most likely be as follows:

- Phase 1 of the implementation strategy would be the forming of a regional logistics organization or alliance consisting of the region's transportation companies. The foundation for this phase has already been laid in the Western Cape region through the presence of Transnet and the Wesgro's free trade portal (refer to section 3.4.1).

- Phase 2 of the implementation strategy would be the development of a regional inland freight consolidation and container terminal facility. The Belcon freight rail facility is a prime example of a facility in the Western Cape supply chain that could be adapted to form the backbone for this phase and could evolve into a fully operational Close-Satellite Marine Terminal, with the primary function of providing a consolidation or deconsolidation point for goods being shipped in or out of a congested maritime port (refer to section 2.4).
- Phase 3 of the implementation strategy would be the development of a dry port. This phase would require significant capital investment and operational capability, thereby enabling the Bellville Precinct to evolve into a Close-Integrated Logistics Park with integrated operations encompassing both import and export functions along with container storage (refer to section 2.4).

9.3 Conclusion

The following conclusions can be drawn from the findings of this study: firstly, the implementation of a dry port could be a feasible expansion option for the Cape Town Container Terminal, due to the presence of the following factors within the Western Cape transportation network:

- **Port Congestion:** the dry port could enable the Port of Cape Town to expand its CY capacity and increase the speed that freight is sent out from its territory, thus relieving congestion and postponing the need for seaward expansion.
- **Road Congestion:** the incorporation of a dry port into the Western Cape transportation network is an opportunity to facilitate the shift from road to rail transportation, thereby alleviating the congestion problem faced by the greater Cape Town area.
- **Environmental Problems:** the incorporation of a dry port into the Western Cape transportation network is an opportunity to alleviate the harmful effect of road transportation on the environment as well as postponing the need for environmentally altering seaward expansion.

Secondly, the development of a dry port at the Bellville Precinct would be able to adhere to the critical needs of volume, seasonality, synergy, distance, location, access to transportation infrastructure and initial investment. The dry port has the potential to create an efficient and environmentally sound transportation corridor, with the following benefits:

- the capacity to shuttle short haul cargoes to and from the dry port, located in the outer metropolitan area of Bellville, would significantly increase the container throughput capacity of the Port of Cape Town and could reduce the congestion within the Cape Town Container Terminal;
- the Port of Cape Town could potentially avoid the grounding of import containers, which could reduce the peak demand on the Cape Town Container Terminal caused by the large volumes of import containers arriving by ship;
- the distribution of trade traffic over the entire system, rather than concentrated at the Port of Cape Town, could increase the efficiency of the system and result in significant savings for shippers and daily users.

Lastly, the implementation of a dry port in the Western Cape supply chain would ensure that the CY area of the Cape Town Container Terminal is no longer the capacity limiting characteristic in the terminal, but rather the container berth capacity. The Port of Cape Town could increase the ports container berth capacity, through the use of either float container cranes, slip berths or the FastNet crane concept. The latter possibly being the most feasible option (refer to section 8.5).

9.3.1 Future studies

The ultimate feasibility of the dry port concept will depend on whether the future stakeholders buy into the concept and, therefore, future research would have to prove that the concept is economically viable for all the relevant stakeholders. The research should focus on the following aspects:

- The quantification of reduced delivery times and its associated costs, due to the presence of a dry port in the supply chain containing. Thereby supporting the notion that a dry port reduces congestion and improves access to multimodal transportation;
- Identifying the competitive advantage gained by regional distributors by obtaining a direct and efficient link to the maritime port, through the presence of the dry port. Thereby encouraging the development of large distribution centres in close proximity to the dry port;
- The quantification of the initial cost that will have to be absorbed by the operating company to ensure that the dry port concept attracts the necessary market buy in to be economically viable. The dry port will not be viable if these costs are transfers to the stakeholders and clients through higher terminal and port charges;

- Developing an implementation strategy to facilitate the successful modal shift from road to rail, due to the fact that this shift has a great influence on the success of the dry port concept;
- Determining the relationship between the additional container movement introduced by the dry port versus the benefits that is gained by transferring the container storage function from the confined maritime port area to a location where storage space is more easily obtained;
- Identifying feasible options for increasing the container berth capacity in the Port of Cape Town.

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Appendix A Existing Dry Ports

A.1 International Dry Ports

A.1.1. Associated British Ports Connect, Hams Hall, Birmingham, United Kingdom

The Associated British Ports Connect, otherwise known as the Hams Hall Channel Tunnel Freight Terminal, was opened in 1997. As of 2010 the site was one of the main dry ports in the United Kingdom. The 10 hectare intermodal rail and road interchange facility is located on the southern edge of Hams Hall Business Park, 12km from the centre of Birmingham.



Figure 62: Location of Associated British Ports Connect

The facility has had customs clearance since 2004 and currently handles over 170 000 TEU per annum and has a storage capacity of 5 000 TEU (IBI Group, 2006). The facility connects with the maritime ports of Southampton, Felixstowe and Ipswich and also connects to Novara in Italy, via the Channel Tunnel.

From the review of the Associated British Ports Connect Terminal, the following factors were identified for the success of a dry port:

- **Initial Investment:** it is important to control initial capital cost. This can be done by adopting a phased development approach, provided that the initial design doesn't preclude phased development.
- **Synergy:** the facility operators have to be directly involved in the dry port design process from the start, to avoid "gold-plating" of the dry ports design.

A.1.2. Coatbridge Freightliner Terminal, Coatbridge, Scotland

The Coatbridge Freightliner Terminal is situated at Coatbridge, Scotland, which is 16km east of Glasgow.



Figure 63: Layout of Coatbridge Freightliner Terminal (IBI Group, 2006)

In the 1990's the Coatbridge Freightliner Terminal was the only freightliner container terminal in Scotland, placing the container terminal in a very strong strategic position, but because of insufficient road access and preferred short sea feeder services from Scotland the container terminal is in danger of closing down (IBI Group, 2006).

From the review of the Coatbridge Freightliner Terminal the following factors were identified for the success of a dry port:

- **Access to transportation infrastructure:** a good mainline rail connection and proximity to motorways are needed.

- **Location:** a dry port needs to be located a suitable distance away from residential areas and needs to have sufficient land for expansion.
- **Distance:** a dry port needs to be located near the centre of production or population for cargo catchment area.

A.1.3. Logport, Duisburg, Germany



Figure 64: Logport

The Logport tri-modal logistics centre project was started in 1998 to offer new options as an optimum logistics location. Logport is located at the former Duisburg-Rheinhausen ironworks site, in the city of Duisburg and is situated on approximately 269 hectares of land with access to river container terminals, nearby airports, road and rail (Leitner & Harrison, 2001). The City of Duisburg, in the German state of North Rhine-Westphalia, is located in the heart of central Europe at the intersection of north-south and east-west traffic. Approximately 30 million consumers live within a 160-kilometer radius of Logport and the state of North Rhine-Westphalia is the most powerful federal German state and Europe's most important market for capital and consumer goods.

The container terminal at Logport started its operation in 2001 and is directly connected with the Port of Duisburg and the Duisburg-Hochfeld coal terminal through a rail shuttle service. Apart from the rail and water connection, Logport also has a good connection via three east-west and two north-south roads. These connections provide an eight (8) hour travel time to reach 40% of the entire European Union population, approximately 150 million consumers (Leitner & Harrison, 2001).

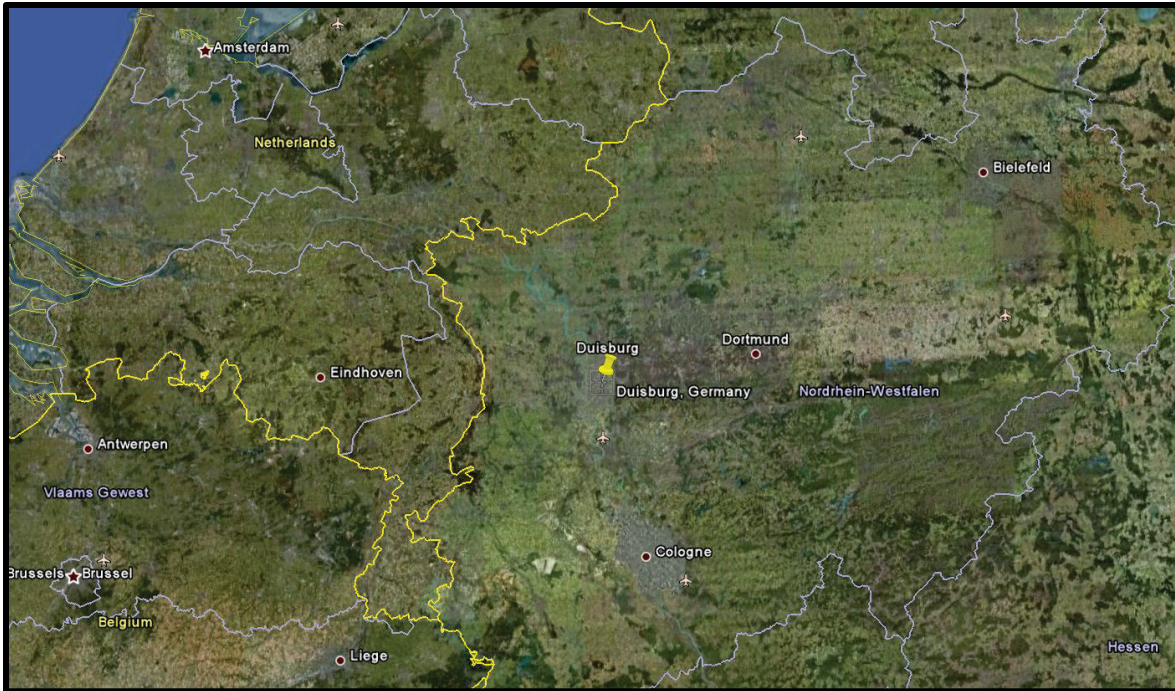


Figure 65: Location of Logport

From the review of Logport the following factors were identified for the success of a dry port:

- **Volume:** Logport is ideally located with access to a very large market base.
- **Initial Investment:** the use of a Brownfield site with pre-existing river and rail access kept the initial investment to a minimum.
- **Synergy:** the role of Duisport management is critical to the success of the dry port, bringing extensive port facility operating and marketing experience to the project.
- **Access to transportation infrastructure:** Logport is connected to multimodal connections such as the German Autobahn system and the InterCityExpress and InterCity long-distance networks of the Deutsche Bahn (German National Railway).
- **Location:** Logport is classed as “industrial space” and offers little or no land-use restrictions under German zoning laws.

A.1.4. Puerto Seco de Madrid, Madrid, Spain



Figure 66: Puerto Seco de Madrid

The Dry Port of Madrid (better known as Puerto Seco de Madrid) is an inland container terminal, which is located in the municipality of Coslada and has a direct rail link to the Spanish Ports of Algeciras, Barcelona, Bilbao and Valencia. Puerto Seco de Madrid forms part of the Trans-European Combined Transport Network. The municipality of Coslada is located in the Madrid metropolitan area, which is the second largest production city in Spain and has a consumer base of more than 7.5million consumers (Trainaviците, 2009). Together with the large consumer base Coslada also has a well established national and international intermodal transport network.

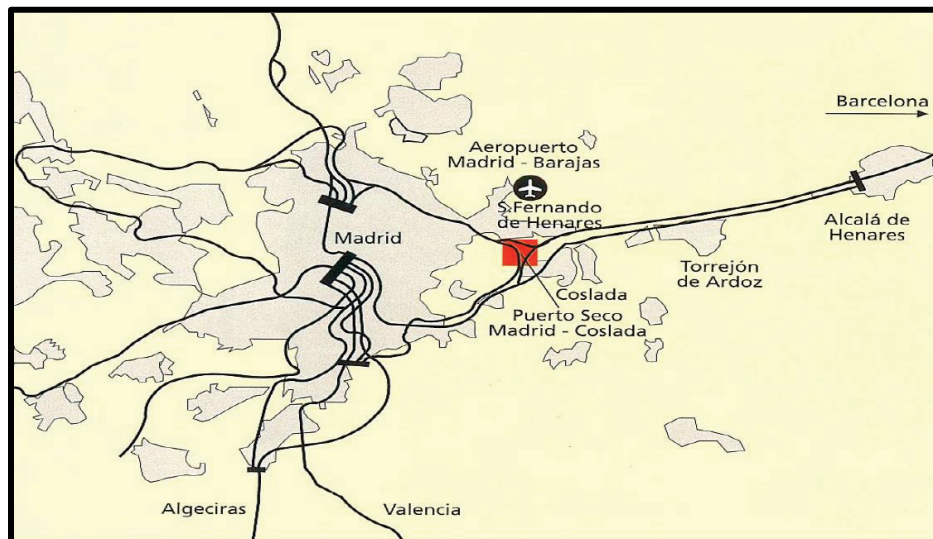


Figure 67: Location of Puerto Seco de Madrid (Trainaviците, 2009)

The location of Puerto Seco de Madrid allows the dry port to handle large container volumes, which are transported over long distances by rail. Moreover, the presence of a number of logistics service companies in the same area allows Puerto Seco de Madrid to be part of a large logistics platform.

Puerto Seco de Madrid was created to serve a double strategic purpose in the Madrid metropolitan area. The first purpose of Puerto Seco de Madrid is to promote the interests of Madrid as a top level logistics platform in Europe and by doing this the state-owned Spanish Port System increases its exposure to the European market. The second purpose is to promote the use of rail transport and reducing road haulage. This enables Puerto Seco de Madrid to align its policy with that of the European Union of boosting combined transport.

The dry port originated from the need of the connected maritime ports to be able to handle the constantly growing cargo volumes and presently the capacity of Puerto Seco de Madrid is reaching 100 000 TEU per year. The dry port handles containers of four maritime ports; however, 60% of the containers relate to the Port of Valencia (Trainaviciute, 2009).

In 2003 the Spanish Government approved a law granting the dry port with all the legal rights to offer custom and inspection regulatory services offered in maritime ports. According to Trainaviciute (2009) the customs clearance at Puerto Seco de Madrid works as follows: In the case of imports, the dry port is the customs office of destination, whereas Barcelona, Bilbao, Valencia or Algeciras are the customs offices of departure. When the train of containers arrives at the dry port, the customs police watch over the containers' security seals. The railway company finishes its transportation work and the containers remain under customs office control. The external transit procedure ends when the required documents are produced at the customs office. Concerning an external transit for exported goods, the dry port is the customs office of departure and the Spanish maritime ports are customs offices of destination.

From the review of Puerto Seco de Madrid the following factors were identified for the success of a dry port:

- **Synergy and Volume:** the four competing maritime ports cooperate in order to share the costs and exploit the economies of scale that can be generated.
- **Distance:** the dry port is supporting the customers with long distance transport services which offer reliability, high quality and relatively small costs.

- **Access to transportation infrastructure:** the direct rail connection between the dry port and maritime ports allows increased flow of goods, thus the intermodal transport is promoted and sustainable transport development is achieved.

A.1.5. Central Euro–Asia Gateway, Jekabpils, Latvia

Central Euro-Asia Gateway is a logistics centre project which is being developed in Latvia, close to the city of Jekabpils. The Central Euro-Asia Gateway is strategically positioned with access to multiple main railway lines, which connect the dry port to six Baltic maritime ports. The dry port is also connected to the Trans-Siberian route and the St. Petersburg-Warsaw railway lines. The project was initiated and is owned by SIA Loģistikas Partneri, the leading logistics and international trade consulting company in Latvia (Trainaviciute, 2009). SIA Loģistikas Partneri is also involved in the development of several logistics centres in Kazakhstan and they are planning to link the logistics centres in Kazakhstan and Central Euro-Asia Gateway into one network. This new network will enable competitive transport between China and Europe and will allow Chinese export companies to transport their goods to Central Euro-Asia Gateway and from there by sea.

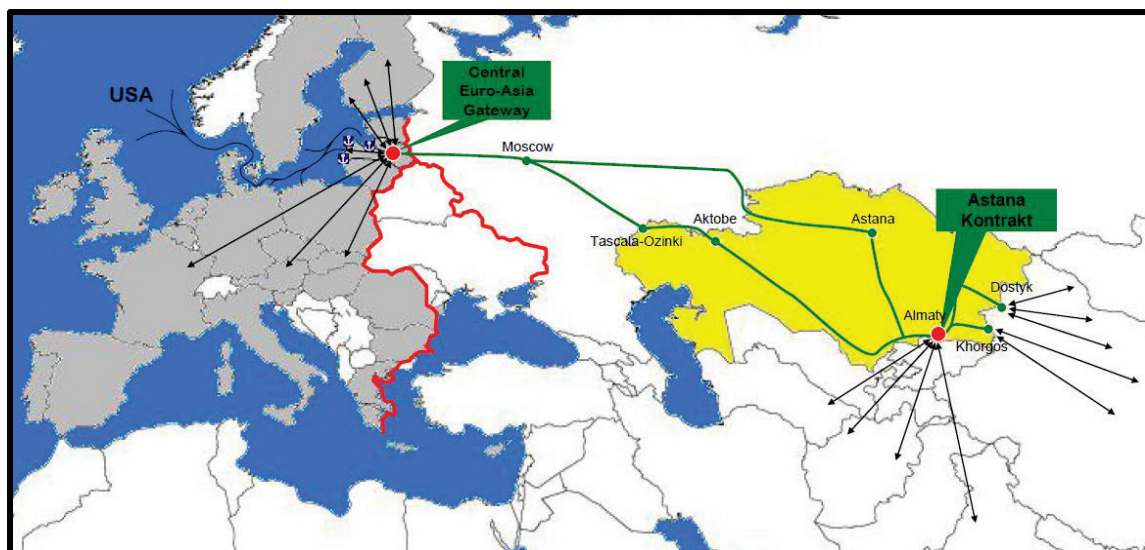


Figure 68: Central Euro-Asia Gateway Connection (Trainaviciute, 2009)

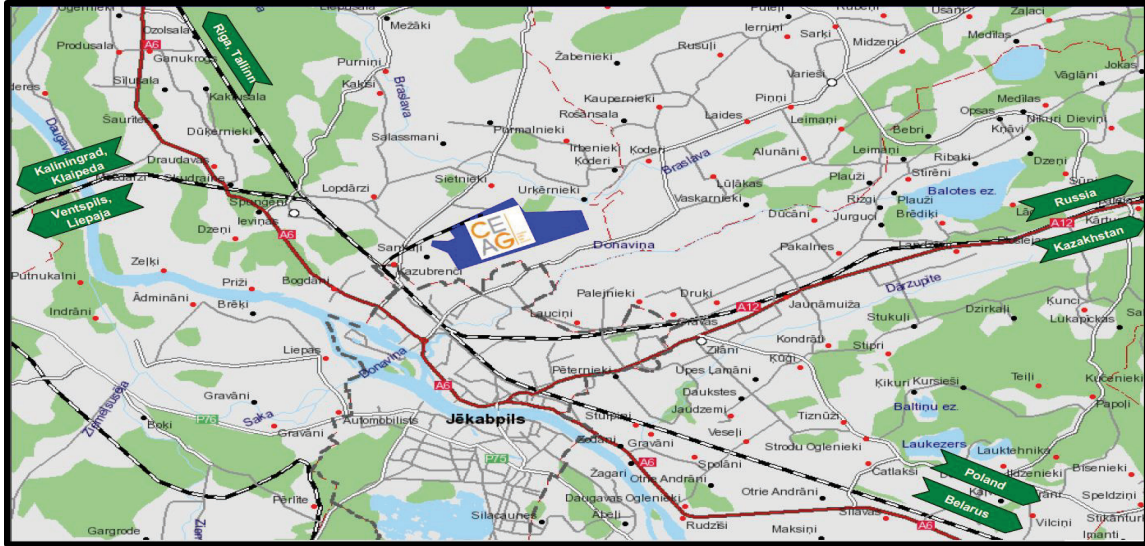


Figure 69: Location of Central Euro-Asia Gateway (Krumins, 2009)

At present the Central Euro-Asia Gateway is in the second stage of development which started in 2011. When the project is fully fledged it will mainly provide consolidating and deconsolidating services to regular container block trains travelling from the Far East to Europe, as well as from Europe and the United States of America to Central Asia via the Baltic maritime ports. The logistics park covers 1.65million m², whereas together with the industrial zones, factories and other facilities the total area is more than 3million m² (Krumins, 2009).

From the review of the Central Euro-Asia Gateway project the following factors were identified for the success of a dry port:

- **Access to transportation infrastructure:** the road and rail networks link the dry port with six Baltic maritime ports and place the dry port in a strategic position.
- **Synergy:** synergy is provided by the direct access of SIA Logistikas Partneri to owners of cargo flows, container terminals and hubs, which serve Far East.
- **Synergy and Initial Investment:** the private initiative and investment together with the political support, have positively contributed to the development of the dry port.
- **Volume:** the high handling capacity (over 0.5million TEU per year), customs clearance and value-added services of the dry port have significantly contributed to the success of the dry port.

A.2 North American Dry Ports

A.2.1. Alliance Texas, Dallas, Texas

Although Alliance Texas does not strictly comply with the definition of a dry port it was added to this study because of its overwhelming success as an inland container terminal.

Alliance Texas is one of the most successful logistics parks in the United States and is located 24km north of downtown Fort Worth and 24km west of Dallas/Fort-Worth International Airport. Alliance is one of the oldest and best researched logistics centres in the world and several researchers have concluded that the Alliance model could be followed for the construction of logistics centres worldwide.

Alliance Texas began operation in 1989 and is a mixed-use, master-planned development which is located on 6 300 hectare of land (HDR Engineering Inc., 2006). Alliance had its origin from a combined effort between the City of Fort Worth, the Federal Aviation Administration and Hillwood for the construction of the world's first purely industrial airport, Fort Worth Alliance Airport.

Alliance is strategically located and connected to a wide range of domestic and international markets through state-of-the-art air, rail and highway systems. The rail connection includes an intermodal facility operated by the Burlington Northern Santa Fe Railway (BNSF). The BNSF facility is capable of handling 1 million lifts per year – a volume that is currently only achieved at large maritime ports such as the Port of Los Angeles (HDR Engineering Inc., 2006). Alliance is provided with adequate highway connection through the presence of Interstate 35W and State Highways 170 and 114.

These connections, together with a foreign trade zone, an enterprise zone, a world trade centre, high-tech telecommunications facilities and an inventory tax exemption greatly enhance business activity at Alliance.

Originally companies were attracted to Alliance because of its availability of relatively inexpensive developable land, access to a large work force, access to intermodal facilities and economic inducements. From its start in 1989 Alliance has attracted more than 140 companies, including 62 industry leaders from the Fortune 500, the Global 500 and the Forbes List of Top Private Companies, which include companies such as, Ryder/Hewlett-Packard, ExxonMobil, FedEx, Honeywell and Motorola. To date nearly US\$4.38 billion have been invested in Alliance,

of which 96.7% are from the private sector (The Tioga Group, Inc., 2006). The presence of these companies has resulted in the growth of Alliance into a 6 300 hectare logistics park providing a wide range of transportation options: intermodal, automotive, transload and carload service with distribution and warehousing (The Tioga Group, Inc., 2006).

Alliance Texas has become one of the most successful public private partnerships in the United States and it is estimated that from 1990 to 2003 Alliance Texas generated a cumulative economic impact of US\$23 billion and created more than 20 000 jobs (HDR Engineering Inc., 2006).

From the review of Alliance Texas the following factors were identified for the success of a dry port:

- **Synergy:** Alliance Texas was one of the first facilities that used the model of a synergistic development of business parks and intermodal terminals.
- **Access to transportation infrastructure:** the presence of effective transportation systems has ensured that Alliance can overcome the obstacle of being away from the Dallas Metro area, which could have caused additional drayage costs.
- **Volume:** the rail intermodal terminal (BSNF facility) was relocated from Dallas to Alliance and therefore had a pre-existing clientele, which helped the growth of Alliance from the start.

A.2.2. California Integrated Logistics Centre, Shafter, California

The California Integrated Logistics Centre is planned to be located near the City of Shafter, north of Bakersfield and will be connected to the Port of Oakland by a rail shuttle. According to The Tioga Group (2006) the facility would serve both domestic and international needs, provide container depot and CFS services and offer a FTZ opportunity.

Currently the Bakersfield market, in which Shafter is situated, is making use of the Southern California maritime ports (port of Los Angeles and Long Beach). The aim of the facility is to intercept the cargo from the Bakersfield market and transport it via the Port of Oakland. This is possible because of the following: by highway Shafter is 410km from Oakland and only 240km from Long Beach, which is why the Bakersfield market was originally tied to the Southern California ports. By rail Oakland and Long Beach are roughly equidistant, 450km to either port depending on the route. Therefore, by improving the rail connection between Shafter and Oakland the Bakerfield cargo can be intercepted (The Tioga Group, Inc., 2006).

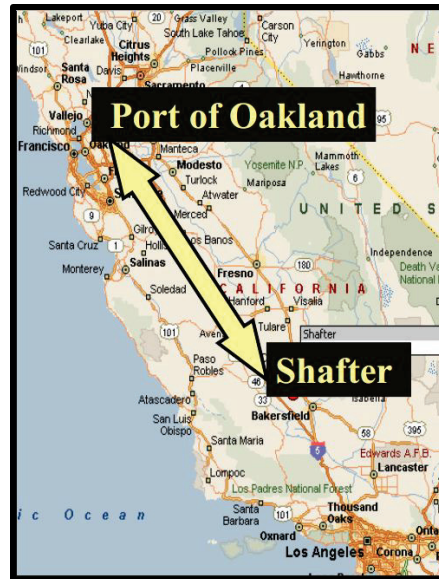


Figure 70: Location of California Integrated Logistics Centre (Green, 2012)

For the California Integrated Logistics Centre to come to a realization, the following obstacles need to be overcome: the centre needs a service commitment from rail system providers and funding is needed because Shafter does not have an existing intermodal terminal.

From the review of the California Integrated Logistics Centre project the following factors were identified for the success of a dry port:

- **Volume and Location:** proximity to a growing export market, which includes products such as: hay, cotton, citrus, almonds and pistachios.
- **Location:** proximity to major import distribution centres, including Sears, IKEA, Target and Wal-Mart (although only Target is adjacent).

A.2.3. Port Inland Distribution Network (PIDN), Port of New York and New Jersey

The PIDN is the intermodal expansion leg of the port redevelopment plan for the PONYNJ that looks to improve the landside distribution of containers. The latest resources predict that PONYNJ has the potential to double the container volumes over the next ten years (Leitner & Harrison, 2001). These predictions led to a redevelopment plan, with the purpose of addressing growth development issues related to land creation, modal split, environmental impacts, return on investment and regional market share.

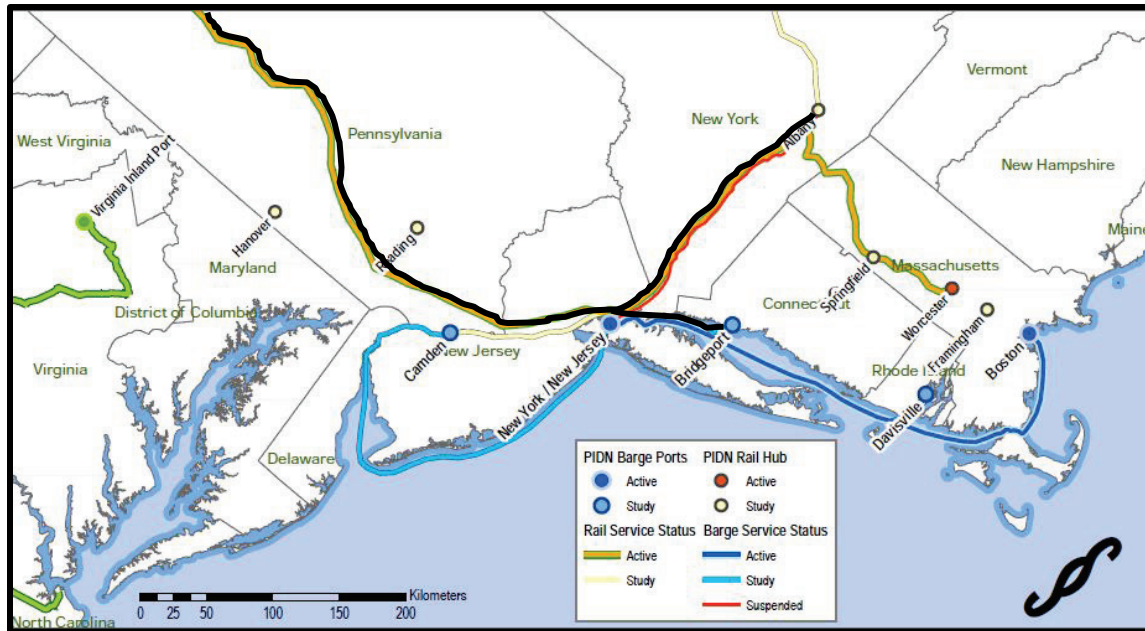


Figure 71: PIDN (Rodrigue, 2007)

The inland container terminals of Albany, New York; Bridgeport, Connecticut; and Harrisburg, Pennsylvania all form part of the PIDN (refer to thick black line on Figure 71). These inland container terminals are linked to PONYNJ by a dedicated transportation network, which consists of rail, barge or tandem trailer-truck shuttles. Projections of container terminal productivity in 2040 show that with the PIDN system modal split will be balanced among more modes, container dwell time at the maritime port will be reduced and vehicle miles travelled within close and far range will be significantly reduced (Leitner & Harrison, 2001).

From the review of the PIDN project the following factors were identified for the success of a dry port:

- **Synergy:** for this project to be successful all the relevant parties will need to buy into the concept.
- **Access to transportation infrastructure:** the PIDN project identified that dry ports need to have adequate access to transportation infrastructure to be successful.
- **Location:** the PIDN project identified that dry ports needs to be located in the maritime ports district and the land has to have the appropriate industrial zoning.

A.2.4. Albany Barge Service, New York

The Albany barge service was an initiative to connect the PONYNJ to the inland river Port of Albany with a barge connection. The operator of the barge was Columbia Coastal, an east coast ocean barge operator.

This project was an element of the Port Authority of New York and New Jersey's Port Inland Distribution Network (PIDN). The project was terminated in 2005 due to the fact that the funding which supported the project was withdrawn. The service operated from Port Elizabeth, New Jersey to Albany, New York, approximately 240km up the Hudson River (The Tioga Group, Inc., 2006).

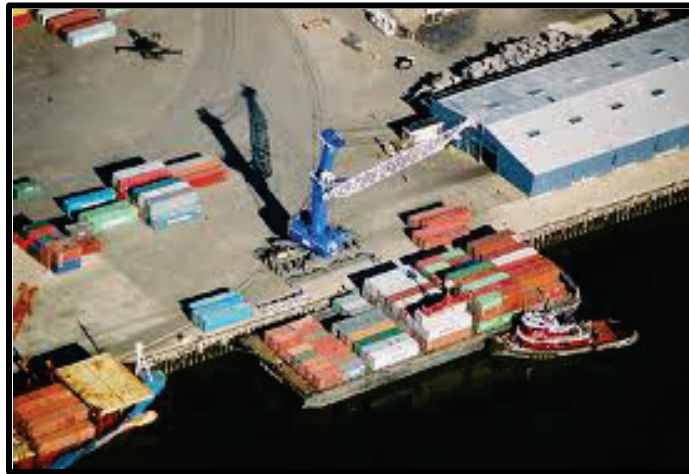


Figure 72: Albany Barge Service

The initial expectation was that ocean carriers and terminal operators would realize the economic and operational benefits of utilizing/supporting the barge service and its “free empty depot” in Albany. Together with these benefits it was also assumed that the service could be priced competitively with trucks. The reality was that the volumes never increased, the free Albany empty depot was not used (The Tioga Group, Inc., 2006). The main problem of the Albany barge service was the inability to attract major shippers and ocean carriers, because of the uncertainty of the long term availability of the barge service.

From the review of the Albany barge service the following factors were identified for the success of a dry port:

- **Synergy:** a dry port can only be successful if the national authority and the major shippers make a long term commitment.

A.2.5. Vancouver Inland Terminal, Vancouver, Canada

The Vancouver Inland Terminal was a small container stuffing facility until the late 1990's. In 1998 Coast Terminals and the Port of Vancouver partnered to develop the dry port in Richmond. Since its start the dry port has experienced phenomenal growth in containerized imports and a demand from the forest products industry.



Figure 73: Location of Vancouver Inland Terminal (MariNova Consulting Ltd., 2006)

The purpose of the dry port is to eliminate empty truck movements on both the import and export side of the logistics network by bringing in a container, de-stuff it and load the container with export cargo. This ensures that the customer gets his cargo much quicker. Furthermore, as in Auckland, the trucker gets two laden moves – one import box and one export box. Although another link has been added to the chain, clients have accepted it because it actually reduces the number of moves by two. This 40 hectare terminal forms part of a 285 hectare parcel of land developed by Fraser River Ports and removes more than 600 truck trips from the roads in the area (MariNova Consulting Ltd., 2006).

From the review of the Vancouver Inland Terminal the following factors were identified for the success of a dry port:

- **Location:** coastal land at the port or waterfront is three times more expensive than the land at the dry port. This reduced land cost significantly reduces cargo cost and kept the initial investment cost to a minimum.
- **Synergy:** the partnership between the Port of Vancouver and Coast Terminals provided the necessary long term commitment needed for the successful start-up of such a project.

Appendix B Forecasted Container Cargo Volumes

B.1 The Transnet Forecast

The data for the Transnet forecast was obtained from the following sources:

- Transnet Limited Annual Report 2010 (Transnet Limited, 2010);
- Transnet Limited Annual Report 2011 (Transnet Limited, 2011);
- Personal interviews with the Cape Town branches of the TNPA, (Birkenstock, 2012) and (Ruthenavelu, 2012), and TPT (Van Schalkwyk, 2011).

Table 24: Container Volume Forecast for Port of Cape Town

Year	2013	2014	2015	2016	2017	2018	2019	2020
Container Volume Forecast ('000 TEU)	827	868	910	956	1003	1053	1105	1159

B.2 The CSCMUS (2009) Adjusted (CSCMUS') Forecast

The CSCMUS (2009) developed a forecast based on growth rates for imports and exports of 75 sectors. These growth rates were developed for the Western Cape containerized trade market and extrapolated up until 2020.

The forecast developed by the CSCMUS (2009) was adjusted in this study to incorporate the actual container cargo volumes up to 2012 and applying the growth rates derived by the CSCMUS (2009) to the container cargo volumes of 2013 and onwards. The original and adjusted forecast volumes are presented in Figure 74.

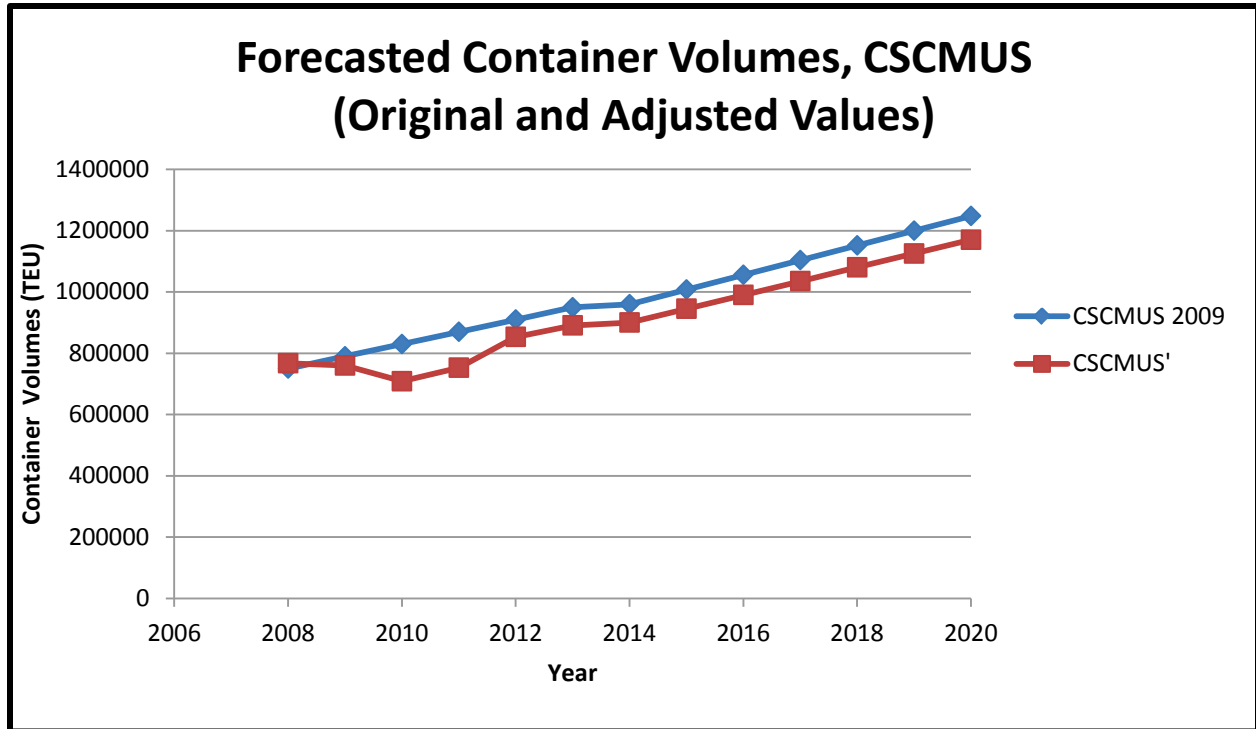


Figure 74: Forecasted Container Volumes, CSCMUS (Original and Adjusted Values)

B.3 The Meyer (2010) Scenario A Adjusted (Meyer Scenario A') Forecast

Meyer (2010) developed three scenarios, namely Scenario A, Scenario B and Scenario C. The author used data developed by the CSCMUS to form the base scenario (Scenario A). This data includes the growth rates for imports and exports of 75 sectors which have been identified up until 2018. The author developed the remaining scenarios by applying the following growth rates:

- **Scenario B:** Scenario A reduced by a negative 10% growth factor;
- **Scenario C:** Scenario A increased by a positive 10% growth factor.

The results of Meyer (2010) are presented in Figure 75.

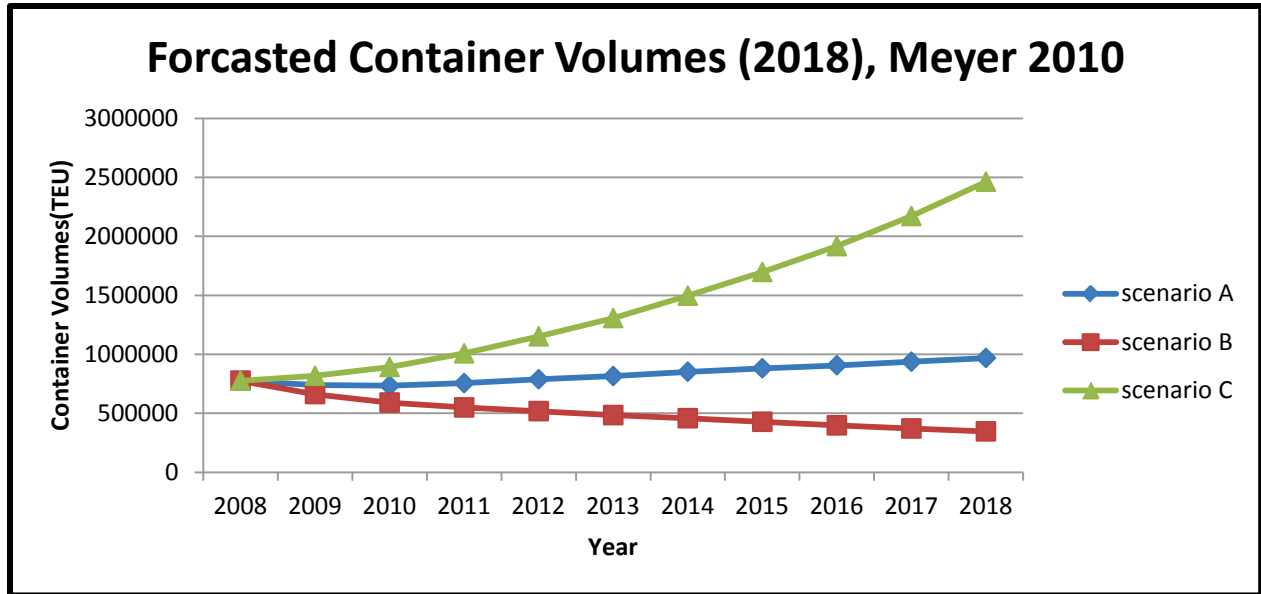


Figure 75: Forecasted Container Volumes (Meyer, 2010)

The three (3) scenarios developed by Meyer (2010) were adjusted in this study to incorporate the actual container cargo volumes up to 2012 and applying the growth rates derived by Meyer (2010) to the container cargo volumes of 2013 and onwards. The original and adjusted scenarios are presented in Figure 76. Scenario A' was used in the comparison of the different container cargo volume forecasts. Scenario B' and Scenario C' were not used because of the following:

- Scenario B' indicates that container cargo volumes will significantly decrease, which is highly unlikely because of the following:
 - Global, African and South African container cargo volumes (discussed in sections 3.2 and 3.3.2 respectively) all indicate that containerized trade is growing.
 - The Western Capes economy has significantly grown over the last couple of years and is expected to continue on this growth path for the foreseeable future (refer to section 3.4).
- Scenario C' indicates that container cargo volumes will grow with a rate greater than 10% (year on year average). This growth rate is unrealistic when compared to past and present container cargo volumes, especially considering that the Port of Ngqura will intercept some of the container volumes previously destined for the Port of Cape Town.

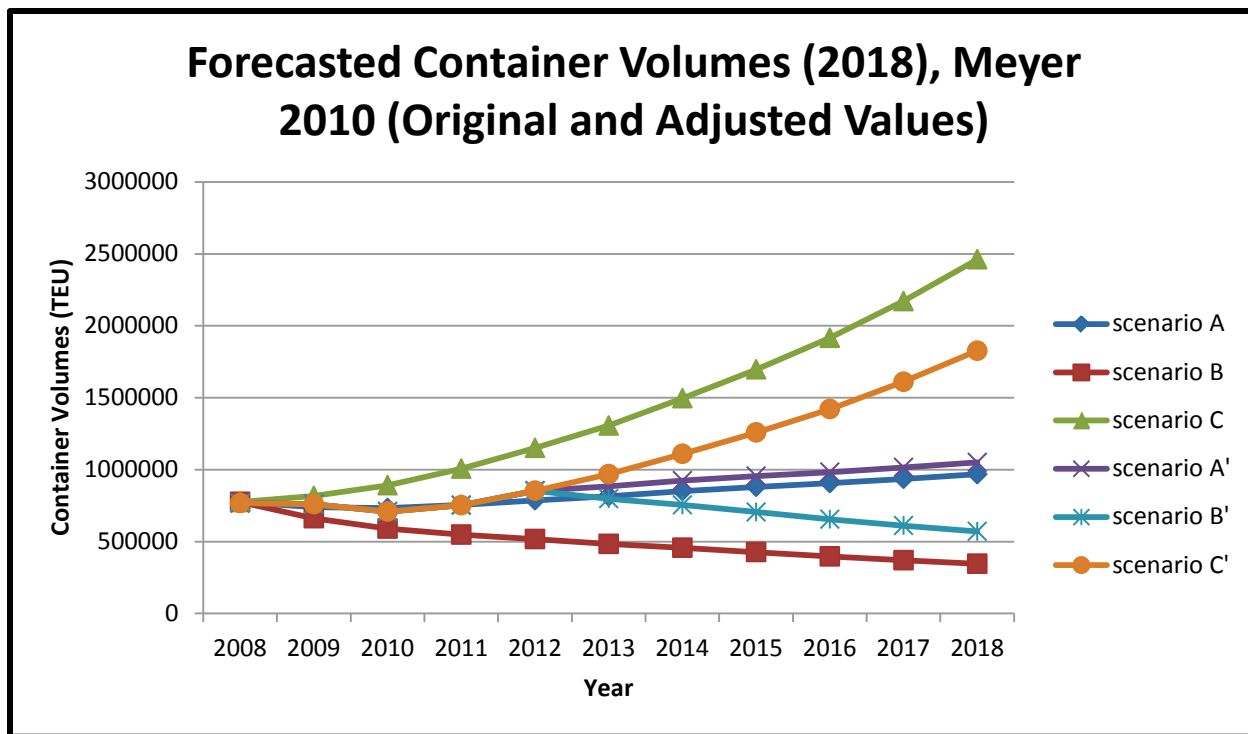


Figure 76: Forecasted Container Volumes, Meyer 2010 (Original and Adjusted Values)

B.4 The Monthly Volumes Forecast

The monthly container volumes forecast was developed by the author of this study and was based on the actual monthly container cargo volumes obtained from Transnet (Van Schalkwyk, 2011) and the Ports & Ships News Letter (Hutson, 2012).

The monthly container cargo volumes of January 2009 to December 2012, as well as the resultant trend line are presented in Figure 77.

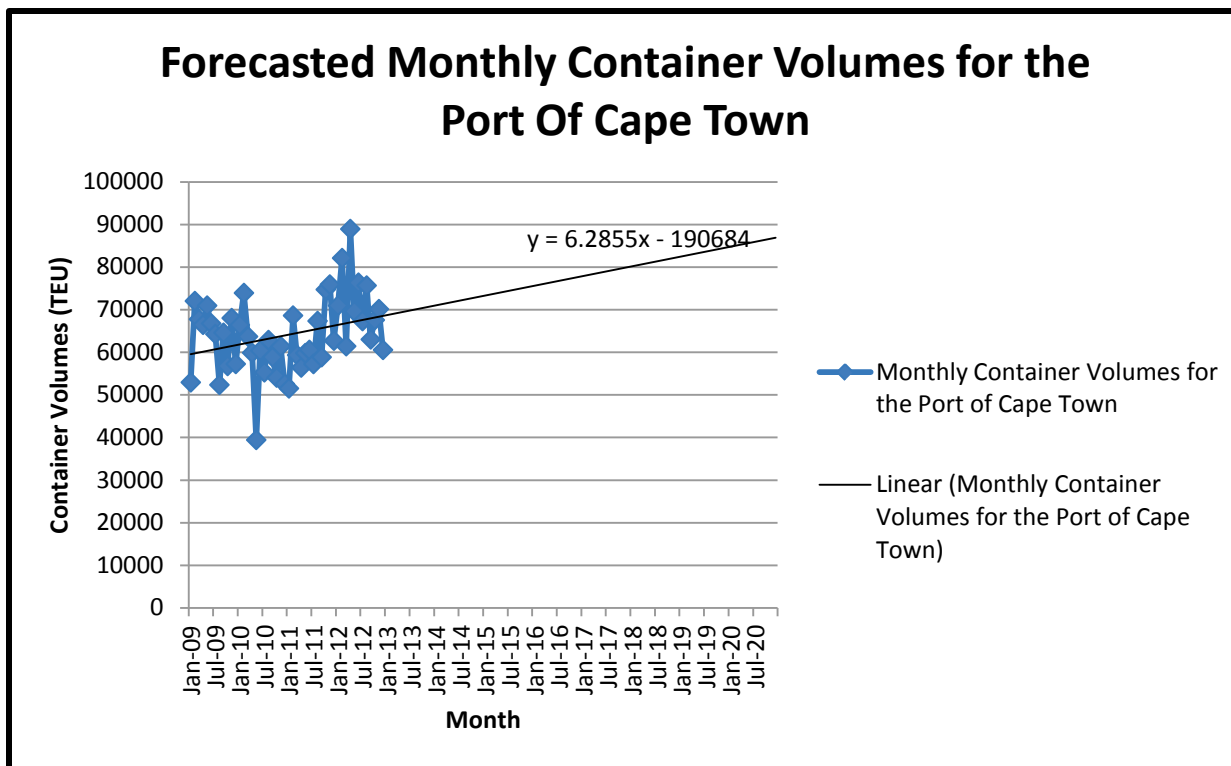


Figure 77: Forecasted Monthly Container Volumes for the Port of Cape Town

The trend line, determined in Figure 77, was used to develop a yearly container cargo volume forecast which is based on the actual monthly container cargo volumes. The forecast is presented in Figure 78.

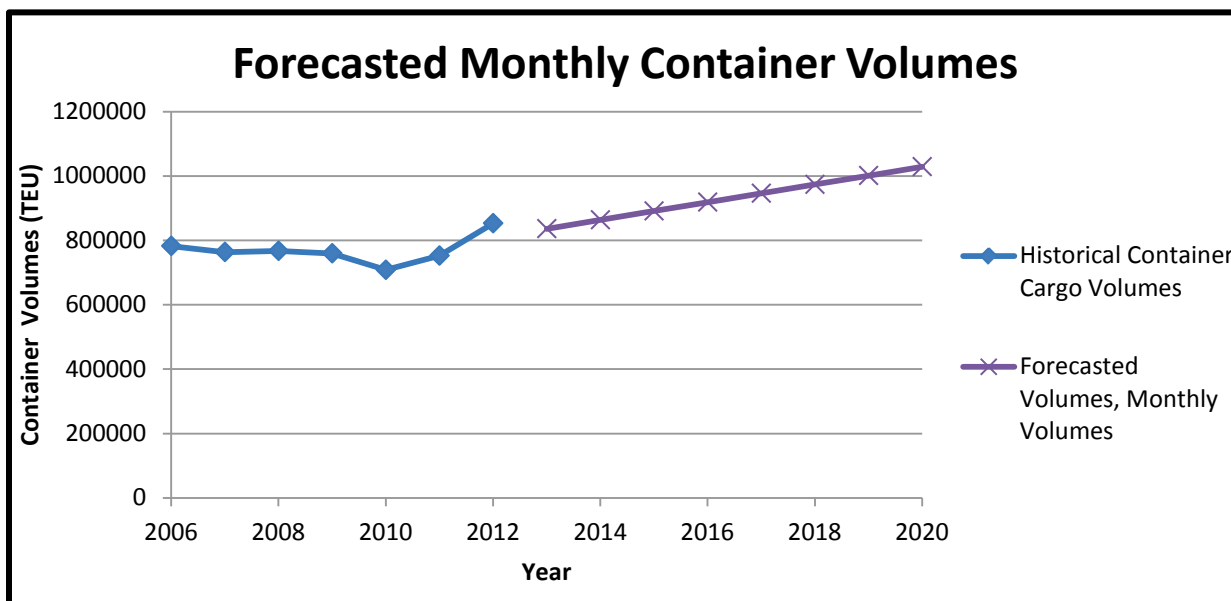


Figure 78: Forecasted Monthly Container Volumes

Appendix C Capacity Limiting Characteristic

C.1 Productivity Metrics

C.1.1. Sustainable CY TEU Capacity

The sustainable CY capacity was estimated by using the following equation:

$$\text{Sustainable CY TEU Capacity} = 0.8 \times \text{maximum annual TEU per Slot} \times \text{TEU Storage Slots} \quad (\text{Equation C1})$$

The maximum annual TEU per slot is benchmarked at 70 TEU per slot (equivalent to about one turn every five days) and the factor of 0.8 is used to determine the sustainable capacity (allowing for business peaks and valleys and a margin for growth). The sustainable CY TEU capacity of the Cape Town Container Terminal (phase 1 and 2) is shown in Table 25.

Table 25: Sustainable CY TEU Capacity

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
TEU Storage Slots	16 158 ^a	32 762 ^b
Sustainable CY TEU Capacity	904 855	1 834 672

Note: a – Refer to Section 4.6.1.

b – Refer to Section 4.6.2.

C.1.2. Annual Container Crane Capacity (TEU)

The annual container crane capacity (TEU) was estimated by using the following equation:

$$\text{Annual Container Crane Capacity (TEU)} = \text{no. of container cranes} \times \text{working hours} \times \text{container moves per hour} \times \left(\frac{\text{TEU}}{\text{Box}} \text{ ratio}\right) \quad (\text{Equation C2})$$

The annual container crane capacity (TEU) of the Cape Town Container Terminal (phase 1 and 2) is shown in Table 26.

Table 26: Annual Container Crane Capacity (TEU)

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Number of Container Cranes	6 ^a	6 ^b
Working Hours	7 700 ^c	7 700 ^c
Container Moves per Hour	20 ^a	30 ^b
TEU/Box Ratio	1.5 ^d	1.5 ^d
Annual Container Crane Capacity (TEU)	1 386 000	2 079 000

Note: a – Refer to Section 4.6.1.

b – Refer to Section 4.6.2.

c – Based on the assumption that container cranes will be in operation fifty (50) weeks a year, seven (7) days a week and twenty-two (22) hours a day (refer to section 4.9.6).

d – Obtained from TPT (Van Schalkwyk, 2011)

C.1.3. Annual Vessel Calls per Berth

The annual vessel calls per berth were determined by dividing the annual vessel calls by the number of available berths. The annual vessels calls per berth of the Cape Town Container Terminal (phase 1 and 2) are shown in Table 27.

Table 27: Annual Vessel Calls per Berth

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Annual Vessel Calls	556 ^b	556 ^b
Number of Berths	4 ^a	4 ^a
Annual Vessels Calls per Berth	139	139

Note: a – Based on the assumption that berths 601, 602, 603 and 604 are the available berths at the container terminal (refer to Figure 27).

b – Obtained from TPT (Van Schalkwyk, 2011)

It should be noted that there is some ambiguity, because of the long berth face of the Cape Town Container Terminal, which can be divided into a variable amount of berths.

C.1.4. Sustainable Vessel Calls per Berth

The sustainable vessel calls per berth was estimated by using the following equation:

$$\text{Sustainable Vessels Calls per Berth} = 0.8 \times \text{maximum vessels calls per berth} \quad (\text{Equation C3})$$

The maximum vessel calls per berth metric are benchmarked at 5 vessels per week and the factor of 0.8 is used to determine the sustainable capacity (allowing for business peaks and valleys and a margin for growth). The sustainable vessel calls per berth of the Cape Town Container Terminal (phase 1 and 2) are shown in Table 28.

Table 28: Sustainable Vessel Calls per Berth

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Maximum Vessel Calls per Berth	260 (52 weeks x 5 vessels per week)	260 (52 weeks x 5 vessels per week)
Sustainable Vessel Calls per Berth	208	208

C.1.5. Maximum Vessel Dimensions

The design draft of the maximum vessel was estimated by using the following equation (The Tioga Group, Inc., 2010):

$$\text{Maximum Design Draft}(m) = (\text{Berth depth}(m) - 0.909m) \times 0.95 \quad (\text{Equation C4})$$

The corresponding Dead Weight Tonnage (DWT) of the maximum vessel was estimated by using the following equation (The Tioga Group, Inc., 2010):

$$\text{Corresponding Max Vessel Size (DWT)} = e^{\left(\frac{((\text{maximum design draft}(m) \times 3.3) + 65.672)}{9.835}\right)} \quad (\text{Equation C5})$$

The corresponding TEU capacity of the maximum vessel was estimated by using the following equation (The Tioga Group, Inc., 2010):

Corresponding Max Vessel Capacity (TEU)

$$= 0.0838 \times \text{corresponding max vessel size (DWT)} - 253.39$$

(Equation C6)

The corresponding vessel length and vessel beam of the maximum vessel were estimated by using the DWT and the TEU capacity, determined using the equations above, and comparing them with actual vessels. The maximum vessel dimensions for the Cape Town Container Terminal (phase 1 and 2) are shown in Table 29.

Table 29: Maximum Vessel Characteristics

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Berth Depth (m)	14 ^a	15.5 ^a
Maximum Design Draft (m)	12.4	13.9
Corresponding Max Vessel Size (DWT)	51 546	83 147
Corresponding Max Vessel Capacity (TEU)	4 000	6 700
Max Vessel Length (m)	270	350
Max Vessel Beam (m)	31.5	45

Note: a – Obtained from TPT (Van Schalkwyk, 2011)

C.1.6. Annual Berth Capacity (TEU) – Maximum Vessel Basis

The annual berth capacity (TEU), maximum vessel basis, was estimated by using the following equation:

$$\text{Annual Berth Capacity (TEU)[Max Vessel Basis]} = \text{Average Discharge \& Load \%} \times \text{Corresponding Max Vessel Capacity (TEU)} \times \text{No. of Available Berths for Max Vessel} \times \text{Sustainable Vessel Calls per Berth}$$

(Equation C7)

The number of available berths that can simultaneously accommodate the maximum vessel size was determined by using the following equation:

$$\text{No. of Available Berths for Max Vessel} = \frac{\text{Berth Length}}{\text{Max Vessel Length} + \text{Max Vessel Beam}} \quad (\text{Equation C8})$$

The average percentage of a vessels container capacity that is handled (loaded and discharged) at the container terminal was determined by using the following equation:

$$\text{Avg Discharge \& Load \%} = \frac{\text{Handled Containers(Loaded\&Discharged)}}{\text{Vessel Capacity(TEU)}} \quad (\text{Equation C9})$$

The annual berth capacity (TEU), maximum vessel basis, of the Cape Town Container Terminal (phase 1 and 2) is shown in Table 30.

Table 30: Annual Berth Capacity (TEU) - Maximum Vessel Basis

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Average Discharge & Load %	50 ^a	50 ^a
Corresponding Max Vessel Capacity (TEU)	4 000 ^b	6 700 ^b
No. of Available Berths for Max Vessel	3.78	2.89
Sustainable Vessel Calls per Berth	208 ^c	208 ^c
Annual Berth Capacity (TEU) – Max Vessel Basis	1 598 952	2 015 324

Note: a – Obtained from TPT (Van Schalkwyk, 2011)

b – Refer to Appendix C.1.5.

c – Refer to Appendix C.1.4.

C.1.7. Average Estimated Vessel Capacity (TEU)

The average estimated vessel capacity (TEU) was estimated by using the following equation:

$$\text{Avg Est Vessel Capacity (TEU)} = \left(\frac{\text{Annual Throughput}}{\text{Annual Vessel Calls}} \right) \times \frac{1}{\text{Average Discharge \& Load \%}} \quad (\text{Equation C10})$$

The average estimated vessel capacity (TEU) for the Cape Town Container Terminal (phase 1 and 2) is shown in Table 31.

Table 31: Average Estimated Vessel Capacity (TEU)

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Average Discharge & Load %	50	50
Annual Throughput (TEU)	800 000	1 400 000
Annual Vessel Calls	556	556
Avg. Est. Vessel Capacity (TEU)	2 878	5 036
Avg. Vessel Length (m)	250	274
Avg. Vessel Beam (m)	32	41

C.1.8. Annual Berth Capacity (TEU) – Average Vessel Basis

The annual berth capacity (TEU), average vessel basis, was estimated by using the following equation:

$$\text{Annual Berth Capacity (TEU)[Avg Vessel Basis]} = \text{Average Discharge \& Load \%} \times \text{Avg Est Vessel Capacity (TEU)} \times \text{No. of Available Berths for Avg Est Vessel} \times \text{Sustainable Vessel Calls per Berth} \quad (\text{Equation C11})$$

The annual berth capacity (TEU), average vessel basis, of the Cape Town Container Terminal (phase 1 and 2) is shown in Table 32.

Table 32: Annual Berth Capacity (TEU) – Average Vessel Basis

Metric	Cape Town Container Terminal Phase 1	Cape Town Container Terminal Phase 2
Average Discharge & Load %	50	50
Avg. Est. Vessel Capacity (TEU)	2 878 ^a	5 036 ^a
No. of Available Berths for Avg. Est. Vessel	4.04	3.62
Sustainable Vessel Calls per Berth	208 ^b	208 ^b
Annual Berth Capacity (TEU) – Avg. Vessel Basis	1 209 858	1 895 444

Note: a – Refer to Appendix C.1.7.

b – Refer to Appendix C.1.4.

C.2 General Design Guidelines

C.2.1. Approach Channel Depth

The approach channel depth was evaluated by using the following equation (Ligteringen & Velsink, 2012):

$$d = D - T + s_{max} + r + m \quad \text{(Equation C12)}$$

Where, d = guaranteed depth.

D = vessel draft.

T = tidal elevation above CD.

s_{max} = maximum sinkage.

r = vertical motion due to wave response, shown to be $0.5 \cdot H_s$.

m = net under keel clearance.

The maximum design vessel draft allowed in the approach channel of the Port of Cape Town is 14.9m as calculated in Table 33 below.

Table 33: Approach Channel Depth

Variable	Outer Channel		Inner Channel	
	Value	Reference	Value	Reference
d	16.7m (below CD)	(Ruthenavelu, 2012)	15.9m (below CD)	(Ruthenavelu, 2012)
T	0.98m	Based on mean sea level	0.98m	Based on mean sea level
S_{max}	0.5m	(Ligteringen & Velsink, 2012)	0.5m	(Ligteringen & Velsink, 2012)
H_s	2.5m	Assumed maximum for safe entry	1.4m	Assumed maximum for safe entry
R	1.25m	$0.5 \times H_s$	0.7m	$0.5 \times H_s$
M	1m	Hard soil or rock (Ligteringen & Velsink, 2012)	0.8m	Hard soil or rock (Ligteringen & Velsink, 2012)
D (vessel draft)	14.9m		14.9m	

C.2.2. Approach Channel Width

The approach channel width was evaluated by using the following equation (Ligteringen & Velsink, 2012):

$$W = (W_{BM} + \sum W_i + 2W_B) \quad (\text{Equation C13})$$

Where, W_{BM} = the basic width.

$$W_i = \text{width additions} = W_{wind} + W_{current-across} + W_{current-long} + W_{wave\ height} + W_{navigation\ aids} + W_{seabed} + W_{cargo\ hazard}$$

W_{wind} = additional width due to wind.

$W_{current-across}$ = additional width due to cross current.

$W_{\text{current-long}}$ = additional width due to long current.

$W_{\text{wave height}}$ = additional width due to wave height.

$W_{\text{navigation aids}}$ = additional width due to the type of available navigation aids.

W_{seabed} = additional width due to the bottom material of the channel.

$W_{\text{cargo hazard}}$ = additional width due to the hazard rating of the cargo.

W_B = the bank clearance.

The maximum design vessel width or beam (B) allowed in the approach channel of the Port of Cape Town is 68m as calculated in Table 34 below.

Table 34: Access Channel Width

Variable	Value	Reference
W_{BM}	1.7B	d<1.25D (Ligteringen & Velsink, 2012) and Table 33
W_{wind}	0.8B	33kn – 48kn (Ligteringen & Velsink, 2012) and section 4.9
$W_{\text{current-across}}$	0.7B	0.5kn – 1.5kn (Ligteringen & Velsink, 2012) and section 4.9
$W_{\text{current-long}}$	0.1B	1.5kn – 3.0kn (Ligteringen & Velsink, 2012) and section 4.9
$W_{\text{wave height}}$	1B	1m – 3m (Ligteringen & Velsink, 2012) and section 4.9
$W_{\text{navigation aids}}$	0.1B	Good (Ligteringen & Velsink, 2012)
W_{seabed}	0.2B	Hard (Ligteringen & Velsink, 2012)
$W_{\text{cargo-hazard}}$	1B	High (Ligteringen & Velsink, 2012)
W_i	3.9B	
W_B	0.5B	Sloping Edge (Ligteringen & Velsink, 2012)
W	450m	(Ruthenavelu, 2012)
B (vessel beam)	68m	

C.2.3. Approach Channel Length

The stopping length needed for the design vessel was evaluated by using the following equation (Ligteringen & Velsink, 2012):

$$L_{st} = L_1 + L_2 + L_3 \quad (\text{Equation C14})$$

Where, L_{st} = stopping length.

$$L_1 = \text{speed reduction} = 0.75 \cdot (V_s - 2) \cdot L$$

V_s = vessel speed in the approach channel.

L = Length overall of the design vessel.

$$L_2 = \text{make fast} = V_{mf} T_{mf} \text{ (if applicable)}$$

V_{mf} = make fast speed.

T_{mf} = make fast time.

$$L_3 = \text{final stop} = 1.5L = 1.5 \times \text{Length of design vessel.}$$

Note that L_2 is only applicable in the situations with adverse wave conditions, where protection is needed for the tugs to make fast, thereby limiting weather downtime. The maximum design vessel length allowed in the approach channel of the Port of Cape Town is greater than 500m as calculated in Table 35 below.

Table 35: Stopping Length

Variable	Value	Reference
V_s	2.5m/s	5kn (Ligteringen & Velsink, 2012)
L_{st}	2 000 (minimum)	(Transnet Limited, 2011)
L_1	0.595L	
L_2	Not applicable	
L_3	1.5L	(Ligteringen & Velsink, 2012)
L	>500m	

C.2.4. Harbour Area – Turning Basin

The turning circle was evaluated by using the following equation (Ligteringen & Velsink, 2012):

$$\text{turning circle diameter} = 1.5 \times L \quad (\text{Equation C15})$$

Where, minimum turning circle diameter = the diameter of the turning circle.

L = Length overall of the design vessel.

The maximum design vessel length allowed in the Ben Schoeman Basin (Cape Town Container Terminal) is 350m as calculated in Table 36 below.

Table 36: Turning Basin

Variable	Value	Reference
Turning circle diameter	525m	(Ruthenavelu, 2012)
L	350m	

C.2.5. Harbour Area – Depth Alongside

The depth alongside was evaluated by using the following equation:

$$d = D + 0.5(\text{sandy seabed}) \quad (\text{Equation C16})$$

Where, d = depth alongside.

D = draft of design vessel.

The maximum design vessel draft allowed in the Ben Schoeman Basin (Cape Town Container Terminal phase 1 and 2) is 13.5m and 15m for phase 1 and phase 2 respectively, as calculated in Table 37 below.

Table 37: Depth Alongside

Phase	Variable	Value	Reference
Cape Town Container Terminal Phase 1	d	14m	(Ruthenavelu, 2012)
	D	13.5m	
Cape Town Container Terminal Phase 2	d	15.5m	(Ruthenavelu, 2012)
	D	15m	

C.2.6. Harbour Area – Basin Width

The basin width was evaluated by using the following equation:

$$W_b = L + B + 50 \quad \text{(Equation C17)}$$

Where, W_b = basin width.

L = length overall of design vessel.

B = beam/width of design vessel

The maximum design vessel beam and length allowed in the Ben Schoeman Basin (Cape Town Container Terminal phase 1 and 2) are presented in Table 38 below.

Table 38: Basin Width

Phase	Variable	Value	Reference
Cape Town Container Terminal Phase 1	W_b	520m	(Ruthenavelu, 2012)
	L	350m	
	B	120m	
Cape Town Container Terminal Phase 2	W_b	500m	(Ruthenavelu, 2012)
	L	350m	
	B	100m	

C.2.7. The Primary Yard Area

Table 39: Primary Yard Area

Phase	Variable	Value				Reference
		Import	Export	Empty	Total	
Cape Town Container Terminal Phase 1	C_{TEU} (TEU/Annum)	166 200	221 600	166 200	554 000	
	A_{TEU} (m ² /TEU)	13	13	13		(Thoresen, 2010)
	D (days)	7	5	7		(Thoresen, 2010)
	B_f	0.1	0.1	0.1		(Thoresen, 2010)
	H	0.8	0.8	0.8		(Thoresen, 2010)
	L	1	1	1		(Thoresen, 2010)
	S	0.8	0.8	0.8		(Thoresen, 2010)
	m_i	0.727	0.727	0.727		(Ligteringen & Velsink, 2012)
	$A_{Thoresen}$ (m ²)	71 218	67 827	71 218	210 264	(Thoresen, 2010)
	$A_{Ligteringen}$ (m ²)	71 219	67 827	71 219	210 266	(Ligteringen & Velsink, 2012)
	A_{actual} (m ²)				210 935	Refer to Table 15
	Cape Town Container Terminal Phase 2	C_{TEU} (TEU/Annum)	336 600	448 800	336 600	1 122 000
A_{TEU} (m ² /TEU)		8	8	8		(Thoresen, 2010)
D (days)		7	5	7		(Thoresen, 2010)
B_f		0.1	0.1	0.1		(Thoresen, 2010)
H		0.8	0.8	0.8		(Thoresen, 2010)
L		1	1	1		(Thoresen, 2010)
S		0.8	0.8	0.8		(Thoresen, 2010)
m_i		0.727	0.727	0.727		(Ligteringen & Velsink, 2012)
$A_{Thoresen}$ (m ²)		88 761	84 534	88 761	262 056	(Thoresen, 2010)
$A_{Ligteringen}$ (m ²)		88 761	84 535	88 761	262 057	(Ligteringen & Velsink, 2012)
A_{actual} (m ²)					271 417	Refer to Table 15

C.2.8. The Secondary Yard Area

Table 40: Secondary Yard Area

Phase	Variable	Value	Reference
Cape Town Container Terminal Phase 1	N	1.151	Refer to Table 15
	A_{ROL} (m ²)	31 750	
	$A_{ROL-Actual}$ (m ²)	31 877	Refer to Table 15
Cape Town Container Terminal Phase 2	N	1.39	Refer to Table 15
	A_{ROL} (m ²)	102 202	
	$A_{ROL-Actual}$ (m ²)	106 964	Refer to Table 15

C.2.9. Hinterland Capacity

Table 41: Hinterland Capacity

Phase	Variable	Value
Cape Town Container Terminal Phase 1	C_{TEU} (TEU/Annum)	554 000
	R_{BT} (TEU/box)	1.5
	W_W (weeks/year)	50
	W_D (days/week)	7
	W_H (hours/day)	22
	C_{BTH} (moves/hour)	36
Cape Town Container Terminal Phase 2	C_{TEU} (TEU/Annum)	1 122 000
	R_{BT} (TEU/box)	1.5
	W_W (weeks/year)	50
	W_D (days/week)	7
	W_H (hours/day)	22
	C_{BTH} (moves/hour)	73

C.2.10. Number of Berths

The number of available berths was evaluated by using the following equation (Ligteringen & Velsink, 2012):

$$\text{Quay Length} = (1.1 \times B_N \times (L_{OA} + 15)) + 15 \quad (\text{Equation C18})$$

Where, Quay Length = the length of quay needed to accommodate the required number of berths.

B_N = number of berths.

L_{OA} = length overall of the design vessel.

The number of available berths at the Cape Town Container Terminal (phase 1 and 2) is shown in Table 42.

Table 42: Number of Available Berths

Phase	Variable	Value	Reference
Cape Town Container Terminal Phase 1	Actual Quay Length (m)	1 140	Refer to Section 4.5
	L_{OA} (m)	250	Avg. Vessel Length, as per Appendix C.1.7
	B_N	3.86	
Cape Town Container Terminal Phase 2	Actual Quay Length (m)	1 140	Refer to Section 4.5
	L_{OA} (m)	274	Avg. Vessel Length, as per Appendix C.1.7
	B_N	3.54	

It should be noted that the number of berths (B_N) does not have to be rounded to the next number of berths due to the fact that this is the annual average and the long quay face at the Cape Town Container Terminal can be divided into different amount of berths throughout the year.

C.2.11. Berth Productivity

The berth productivity was evaluated by using the following equation (Ligteringen & Velsink, 2012):

$$c_b = G_{BH} \times F_{TEU} \times C_N \times W_H \times W_D \times W_W \times \frac{B_{OR}}{100} \quad (\text{Equation C19})$$

Where, c_b = average annual number of TEU per berth.

G_{BH} = number of container boxes handled/container crane/hour.

F_{TEU} = (number of 20-foot units + 2 x number of 40-foot units) / (number of 20-foot units + number of 40-foot units) = TEU-factor.

C_N = total number of STS gantry cranes working on each container ship.

W_D = workings days per week.

W_H = working hours per day.

W_W = number of working weeks per year.

B_{OR} = berth occupancy ratio in percentage.

The berth productivity at the Cape Town Container Terminal (phase 1 and 2) is presented in Table 43.

Table 43: Berth Productivity

Phase	Variable	Value	Reference
Cape Town Container Terminal Phase 1	G_{BH} (moves/hour)	20	(Transnet Limited, 2011)
	F_{TEU}	1.6	Equivalent to $R_{BT}=1.5$
	C_N (cranes/berth)	1.55	6 cranes and 3.86 berths as determined in Appendix C.2.10
	W_H (hours/day)	22	Refer to Section 4.9.6
	W_D (days/week)	7	Refer to Section 4.9.6
	W_W (weeks/year)	50	Refer to Section 4.9.6
	B_{OR} (%)	50	Assumed reasonable utilisation
	c_b (TEU/berth/annum)	190 960	
Cape Town Container Terminal Phase 2	G_{BH} (moves/hour)	30	(Transnet Limited, 2011)
	F_{TEU}	1.6	Equivalent to $R_{BT}=1.5$
	C_N (cranes/berth)	1.7	6 cranes and 3.54 berths as determined in Appendix C.2.10
	W_H (hours/day)	22	Refer to Section 4.9.6
	W_D (days/week)	7	Refer to Section 4.9.6
	W_W (weeks/year)	50	Refer to Section 4.9.6
	B_{OR} (%)	50	Assumed reasonable utilisation
	c_b (TEU/berth/annum)	1 112 126	

Appendix D Size Characteristics of the Dry Port

D.1 The Primary Yard Area

The primary yard area consists of four (4) main areas, namely import yard area, export yard area, empty yard area and CFS area.

Import, export and empty yard areas were calculated by using the following equation (Thoresen, 2010):

$$A = \frac{C_{TEU} \times A_{TEU} \times D \times (1 + B_f)}{365 \times H \times L \times S} \quad (\text{Equation D1})$$

The value of A was justified by using the following equation (Ligteringen & Velsink, 2012):

$$A = \frac{C_{TEU} \times D \times A_{TEU}}{H \times 365 \times m_i} \quad (\text{Equation D2})$$

The CFS includes area for the stuffing and stripping of the containers and was determined using the following equation (Ligteringen & Velsink, 2012):

$$A_{CFS} = \frac{C_{TEU} \times D \times V \times f_1 \times f_2}{h_a \times m_i \times 365} \quad (\text{Equation D3})$$

Where, A_{CFS} = total yard area needed for containers going through the CFS.

C_{TEU} = container throughput per year at the container freight station = it was assumed that 20% of the total dry port throughput will pass through the CFS.

V = the content volume of 1 container (TEU) = 29m³.

f_1 = gross area/net area in the CFS.

f_2 = bulking factor.

h_a = average height of cargo in the CFS.

The required import, export and empty container yard areas as well as CFS area is calculated in Table 44 below.

Table 44: Primary Yard Area

Variable	Value					Reference
	Import	Export	Empty	CFS	Total	
C_{TEU} (TEU/Annum)	210 000	280 000	210 000	140 000	700 000	
A_{TEU} (m ² /TEU)	13	13	13			(Thoresen, 2010)
D (days)	5	10	15	5		(Thoresen, 2010)
B_f	0.1	0.1	0.1			(Thoresen, 2010)
H	0.8	0.8	0.8			(Thoresen, 2010)
L	1	1	1			(Thoresen, 2010)
S	0.8	0.8	0.8			(Thoresen, 2010)
m_i	0.727	0.727	0.727	0.727		(Ligteringen & Velsink, 2012)
V (m ³)				29		(Ligteringen & Velsink, 2012)
f_1				1.4		(Ligteringen & Velsink, 2012)
f_2				1.1		(Ligteringen & Velsink, 2012)
h_a				3		(Ligteringen & Velsink, 2012)
$A_{Thoresen}$ (m ²)	64 276	171 404	192 830	39 256 (Ligteringen & Velsink, 2012)	467 766	(Thoresen, 2010)
$A_{Ligteringen}$ (m ²)	64 277	171 405	192 830	39 256	467 768	(Ligteringen & Velsink, 2012)

D.2 Storage Slots

The number of storage slots was calculated by using the following equation (Thoresen, 2010):

$$S_L = \frac{A_{IMPORT}}{A_{TEU}} \quad (\text{Equation D4})$$

Where, S_L = total number of container storage slots at the primary yard area.

A = total yard area needed for imported containers.

A_{TEU} = area required per TEU depending on the container handling system.

The required amount of storage slots of the dry port is shown in Table 45 below.

Table 45: Storage Slots

Variable	Value				Reference
	Import	Export	Empty	Total	
$A_{\text{Thoresen}} \text{ (m}^2\text{)}$	64 276	171 404	192 830		(Thoresen, 2010)
$A_{\text{TEU}} \text{ (m}^2\text{/TEU)}$	13	13	13		(Thoresen, 2010)
S_L	4 944	13 185	14 833	32 962	

D.3 The Secondary Yard Area

The required secondary yard area for the dry port was determined by using the following equation (Thoresen, 2010):

$$A_{ROL} = (A_{IMPORT} + A_{EXPORT} + A_{EMPTY} + A_{CFS}) \times (N - 1) \quad (\text{Equation D5})$$

The required secondary yard area of the dry port is calculated in Table 46 below.

Table 46: Secondary Yard Area

Variable	Value	Reference
A_{IMPORT} (m ²)	64 276	
A_{EXPORT} (m ²)	171 404	
A_{EMPTY} (m ²)	192 830	
N	39 256	
A_{ROL} (m ²)	2	(Thoresen, 2010)
A_{IMPORT} (m ²)	467 766	

D.4 Total Land Area

The total land area was calculated by using the following equation:

$$A_{TOTAL} = A_{IMPORT} + A_{EXPORT} + A_{EMPTY} + A_{CFS} + A_{ROL} \quad (\text{Equation D6})$$

The total land area required for the dry port is calculated in Table 47 below.

Table 47: Total Land Area

Variable	Value
A_{IMPORT} (m ²)	64 276
A_{EXPORT} (m ²)	171 404
A_{EMPTY} (m ²)	192 830
A_{CFS} (m ²)	39 256
A_{ROL} (m ²)	467 766
A_{TOTAL} (m ²)	935 532

D.5 Hinterland Capacity

The required hinterland capacity was calculated by using the following equation (Thoresen, 2010):

$$C_{BTH} = \frac{C_{TEU}}{R_{BT} \times W_W \times W_D \times W_H} \quad (\text{Equation D7})$$

The required hinterland capacity of the dry port facility will be 45 moves per hour as calculated in Table 48 below.

Table 48: Hinterland Capacity

Variable	Value
C_{TEU} (TEU/Annum)	700 000
R_{BT} (TEU/box)	1.5
W_W (weeks/year)	50
W_D (days/week)	7
W_H (hours/day)	22
C_{BTH} (moves/hour)	45

D.6 CY Capacity Utilization

The CY Capacity Utilization was determined by dividing the annual throughput (TEU) by sustainable CY TEU capacity (throughput as a percentage of capacity).

The CY Capacity Utilization of the proposed dry port is shown in Table 49.

Table 49: CY Capacity Utilization (%)

Metric	Proposed Dry Port	Reference
Annual Throughput (TEU)	700 000	Refer to section 7.4
Sustainable CY TEU Capacity	2 307 363	
CY Capacity Utilization (%)	38	

Appendix E Site Selection Analysis

E.1 Neutral Weighting

Table 50: Site Selection Analysis - Neutral Weighting

<u>Site Characteristics</u>	<u>Weighting</u>	<u>Locations</u>			
		Requirement (2039)	Bellville Precinct	Kraaifontein area	Ysterplaat Air Force Base
<u>Property</u>					
Size (ha)	1	>93.5ha	3	3	3
Minimum Width (m)	1	>300m	3	3	3
Minimum Length (m)	1	>1 500m	3	3	3
Expansion (ha) for adjacent development	1	>50ha	3	3	3
Zoning Non residential	1	Yes	3	2	3
Security Ranking (from 1 to 10)	1	>5	3	3	3
Major Structure Relocation Required	1	No	3	3	2
Major Demolition Required	1	No	3	3	3
<u>Acquisition</u>					
Land Value	1	N.A.	3	3	3
Estimated Expropriate Cost	1	Low	3	2	2
Assembly Costs	1	Low	3	1	2
<u>Environmental Condition of Site</u>					
Contamination	1	Low	3	3	3
Eco-sensitive	1	Low	3	3	3
Biophysical and Cultural Resources	1	<Medium	3	3	3
<u>Socio/Economic</u>					
<u>Compatibility</u>					
Neighbours (Type)	1	Non-Residential / Agricultural	3	2	3
Operating Hours Restrictions	1	No	3	3	3
Major Local Opposition	1	Low	3	1	1
Likely Job Impact (creation)	1	>Medium	3	3	3
Planning Issues	1	Low	3	3	3

Topography					
Railway Level	1	Yes	3	3	3
Natural Physical Impediments	1	None	3	3	3
Geotechnical acceptable	1	Yes	3	3	3
Access					
Trucking					
New Freeway Interchange Required	1	No	3	3	3
Local Access Road Reasonable	1	Yes	3	3	3
Proximity of Freeway	1	<1km	2	3	3
Rail					
Major Structures Required	1	No	1	1	1
Proximity of Railway	1	<500m	3	3	3
Utilities					
Communication/Electrical	1	Yes	3	2	3
Water/Gas/Sewer	1	Yes	3	2	3
Location					
Trucking Partners					
Distance to Customer Epicentre (km)	1	<50km	3	3	3
Railway					
Distance to Maritime Port (km)	1	<50km	3	3	3
Direct Line	1	Yes	3	2	3
Overhead Electrical Lines	1	Yes	3	2	2
Market Demand					
Import Shipment Volumes	1	>Medium	3	2	3
Export Shipment Volumes	1	>Medium	3	2	3
Potential customers (Agriculture, mining, manufacturing and trade establishments)	1	>Medium	3	3	3
Population Growth	1	>Medium	3	3	3
Total					
Score			108	96	103
Percentage Scored			97.3%	86.5%	92.8%
Ranking			1	3	2

E.2 Subjective Weighting

Table 51: Site Selection Analysis – Subjective Weighting

<u>Site Characteristics</u>	<u>Weighting</u>	<u>Locations</u>			
		Requirement (2039)	Bellville Precinct	Kraaifontein area	Ysterplaat Air Force Base
<u>Property</u>					
Size (ha)	3	>93.5ha	9	9	9
Minimum Width (m)	3	>300m	9	9	9
Minimum Length (m)	3	>1 500m	9	9	9
Expansion (ha) for adjacent development	3	>50ha	9	9	9
Zoning Non residential	2	Yes	6	4	6
Security Ranking (from 1 to 10)	1	>5	3	3	3
Major Structure Relocation Required	2	No	6	6	4
Major Demolition Required	2	No	6	6	6
<u>Acquisition</u>					
Land Value	3	N.A.	9	9	9
Estimated Expropriate Cost	3	Low	9	6	6
Assembly Costs	3	Low	9	3	6
<u>Environmental Condition of Site</u>					
Contamination	1	Low	3	3	3
Eco-sensitive	1	Low	3	3	3
Biophysical and Cultural Resources	1	<Medium	3	3	3
<u>Socio/Economic</u>					
<u>Compatibility</u>					
Neighbours (Type)	2	Non-Residential / Agricultural	6	4	6
Operating Hours Restrictions	2	No	6	6	6
Major Local Opposition	2	Low	6	2	2
Likely Job Impact (creation)	1	>Medium	3	3	3
Planning Issues	1	Low	3	3	3

<u>Topography</u>					
Railway Level	3	Yes	9	9	9
Natural Physical Impediments	2	None	6	6	6
Geotechnical acceptable	2	Yes	6	6	6
<u>Access</u>					
Trucking					
New Freeway Interchange Required	1	No	3	3	3
Local Access Road Reasonable	2	Yes	6	6	6
Proximity of Freeway	3	<1km	6	9	9
Rail					
Major Structures Required	2	No	2	2	2
Proximity of Railway	3	<500m	9	9	9
<u>Utilities</u>					
Communication/Electrical	1	Yes	3	2	3
Water/Gas/Sewer	1	Yes	3	2	3
<u>Location</u>					
Trucking Partners					
Distance to Customer Epicentre (km)	2	<50km	6	6	6
Railway					
Distance to Maritime Port (km)	2	<50km	6	6	6
Direct Line	3	Yes	9	6	9
Overhead Electrical Lines	2	Yes	6	4	4
<u>Market Demand</u>					
Import Shipment Volumes	3	>Medium	9	6	9
Export Shipment Volumes	3	>Medium	9	6	9
Potential customers (Agriculture, mining, manufacturing and trade establishments)	2	>Medium	6	6	6
Population Growth	1	>Medium	3	3	3
<u>Total</u>					
Score			224	197	213
Percentage Scored			97.0%	85.3%	92.2%
Ranking			1	3	2